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PROCEEDINGS

OF THE

AMERICAN SOCIETY

OF

CIVIL ENGINEERS

(INSTITUTED 1852)

VOL. XXXVII—No. 6
AUGUST, 1911

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NEW YORK 1911.

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American Society of Civil Engineers

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◆

The House of the Society is open from 9 A. M. to 10 P. M. every day, except Sundays, Fourth of July, Thanksgiving Day, and Christmas Day.

HOUSE OF THE SOCIETY—220 WEST FIFTY-SEVENTH STREET, NEW YORK.

TELEPHONE NUMBER..................5913 Columbus.
CABLE ADDRESS...................."Ceas, New York."

Vol. XXXVII. AUGUST, 1911. No. 6.

AMERICAN SOCIETY OF CIVIL ENGINEERS

INSTITUTED 1852

PROCEEDINGS

This Society is not responsible for any statement made or opinion expressed in its publications.

SOCIETY AFFAIRS

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MINUTES OF MEETINGS

OF THE SOCIETY

May 17th, 1911.—The meeting was called to order at 8.30 P. M.; E. Kuichling, M. Am. Soc. C. E., in the chair; Chas. Warren Hunt, Secretary; and present, also, 99 members and 10 guests.

A paper by Charles Arthur Hague, M. Am. Soc. C. E., entitled "The Present-Day Pumping Engine for Water-Works," was presented by the author and illustrated with lantern slides. The Secretary presented a written communication on the subject by Charles B. Buerger, Assoc. M. Am. Soc. C. E., and the paper was discussed orally by Messrs. E. Kuichling, J. H. Gregory, G. A. Orrok, Kenneth Allen, and the author.

Adjourned.

June 7th, 1911.—The meeting was called to order at 8.30 P. M.; A. L. Bowman, M. Am. Soc. C. E., in the chair; Chas. Warren Hunt, Secretary; and present, also, 123 members and 16 guests.

The minutes of the meetings of April 19th and May 3d, 1911, were approved as printed in *Proceedings* for May, 1911.

A paper by D. C. Henny, M. Am. Soc. C. E., entitled "Two Earth Dams of the United States Reclamation Service," was presented by the Secretary, who also read a discussion on the subject by James Dix Schuyler, M. Am. Soc. C. E.

A paper by Wilbur J. Watson, M. Am. Soc. C. E., entitled "Steel Centering Used in the Construction of the Rocky River Bridge, Cleveland, Ohio," was presented by the Secretary.

The Secretary announced the election of the following candidates on June 6th, 1911:

As Members

Theodore Hastings Bacon, Armstead, Mont.
Hugh Cunningham Banks, San Francisco, Cal.
Maxwell Cunningham Byers, Springfield, Mo.
Abraham Lincoln Fellows, Denver, Colo.
Henry Floy, New York City.
Charles Richard Hedke, Fort Collins, Colo.
Henry Clarence Hodgkins, Syracuse, N. Y.
Ben Johnson, Gatun, Canal Zone, Panama.
Howard Lothrop, Fall River, Mass.
James Cornelius Murphy, Louisville, Ky.
Walter Raleigh Okeson, New York City.
Robert Winthrop Pratt, Columbus, Ohio.
Cesar de Sá Rabello, Rio de Janeiro, Brazil.
Edgar Franklin Robinson, Rochester, N. Y.
Harry Asahel Storrs, Denver, Colo.
Hiram Everett Terry, Flint, Mich.
William Love Thompson, Corozal, Canal Zone, Panama.
Benjamin Ellsworth Tilton, Rochester, N. Y.
Francis John Tresise, Buffalo, N. Y.
George Alpha Winsor, Valhalla, N. Y.
George Pillsbury Wood, Peekskill, N. Y.

As Associate Members

Charles Rollin Allen, Jr., Mechanicville, N. Y.
Frank LaFayette Anders, Fargo, N. Dak.
Frank Foy Axtell, Port Arthur, Tex.
Frederick Louis Bixby, Agricultural College, N. Mex.
Arthur Maximillien Bouillon, St. John, N. B., Canada.
Chauncey Allison Burnette, Seattle, Wash.

Elias Cahn, New York City.
Hartley Robert Church, Berkeley, Cal.
Fred Winslow Claflin, Holsopple, Pa.
Thomas Edward Collins, Pottsville, Pa.
James Roger Crocker, New York City.
Harold James Doolittle, North Yakima, Wash.
Ralph Selden Edmondson, High Falls, N. Y.
Francisco José Gaston y Rosell, Isabela de Sagua, Cuba.
Arthur Ripont Keller, Honolulu, Hawaii.
George Walter Koss, Des Moines, Iowa.
William Louis Kuehnle, New York City.
Frederick Washington Lawson, Perth, Western Australia.
Walter Powell Linton, Manila, Philippine Islands.
Oro McDermith, Newell, S. Dak.
George Moncur, Glasgow, Scotland.
Clare Joseph Moody, Ronan, Mont.
William Clyde Mundt, Tulsa, Okla.
Francis Joseph O'Hara, Wampus, Ore.
Daniel Berry Packard, Washington, N. C.
Charles Albert Riggs, Newport, Ky.
Stephen Allen Roake, Trenton, N. J.
Frederick Thurston Robson, San Francisco, Cal.
Frederick William Scheidenhelm, Connellsville, Pa.
William Henry Seaman, Glen Cove, N. Y.
Charles Stephen Shaughnessy, Cold Spring, N. Y.
John Earl Shoemaker, Pueblo, Colo.
Allen Whitmore Stephens, East Orange, N. J.
Vernon Lyle Sullivan, Buenavista, Tex.
Leslie Flanders Van Hagan, Madison, Wis.
Harry Rogers Wickham, Rochester, N. Y.
James Henry Williams, Fort Meade, S. Dak.

As Associate

Edward Coe Dilworth, Pittsburg, Pa.

As Juniors

Pendleton Beall, Poughkeepsie, N. Y.
James Buckley Black, St. Louis, Mo.
William Arthur Burton, Springfield, Mo.
Antonio Castillo y Grau, Cienfuegos, Cuba.
John James Crotty, St. Louis, Mo.
Merton James Douthitt, Chicago, Ill.
Virgil Allen Eberly, Culebra, Canal Zone, Panama.
Edward Hall Gill, Denver, Colo.
Harry Parker McKean, La Junta, Colo.

Alvin Rush Murphy, New York City.
James Elwood Payne, New York City.
Henry Boutwell Smith, Gatun, Canal Zone, Panama.
John Henry Spengler, Troy, N. Y.
William Tufts, Boston, Mass.
Elliott Vandevanter, Baltimore, Md.
Arthur Vosbury Vanneman, Newburg, W. Va.
Chester Gordon Wells, Pocatello, Idaho.
Henry Belcher Wheatcroft, Jr., New York City.
Howard McClymonds Yost, Massillon, Ohio.
Oliver Earle Young, Lincoln, Ala.

The Secretary announced the transfer of the following candidates on June 6th, 1911:

From Associate Member to Member

Charles Enzian, Wilkes-Barre, Pa.
Chester James Hogue, Boston, Mass.
William Augustus Howell, Newark, N. J.
Howard Elmer Hyde, Havana, Cuba.
Elbert Emerson Lochridge, Springfield, Mass.
Robert Henry McPherson, New York City.
George Pillsbury Morrill, Sagua la Grande, Cuba.
Harry Edward Wagner, Andover, N. J.
William DeWitt Waltman, San Acacio, Colo.
Herbert Sedgwick Wilgus, Angelica, N. Y.

From Associate to Associate Member

Robert Hileman Lee, Cleveland Heights, Ohio.

From Junior to Associate Member

Chester Daniel Ashbrook, Chatcolet, Idaho.
Albert Sereno Brainard, Hartford, Conn.
Howard Emory Bushnell, Newark, N. J.
Charles Gilman, Plainfield, N. J.
Ralph Weller Greenlaw, Cold Spring, N. Y.
Russell Edwin Harrison, Grand Rapids, Mich.
Carl Hugo Jabelonsky, Spokane, Wash.
Gilbert Garfield Jacobosky, Wilkes-Barre, Pa.
William John Millard, Kanyama, Congo Belge, West Africa.
Henry Schell Nichol, Victoria, B. C., Canada.
Joseph Shema, Wheeling, W. Va.
Harry Edwin Squire, Bremerton, Wash.
Frederick Sampson Weston, Middleboro, Mass.

From Junior to Associate

Robert Breck Moran, San Francisco, Cal.

The Secretary announced the following deaths:

Roswell Emmons Briggs, elected Member, September 15th, 1869; died May 4th, 1911.

Alfred Courtney Lewerenz, elected Junior, March 5th, 1895; Associate Member, June 6th, 1900; and Member, March 6th, 1906; died May 27th, 1911.

Charles Widney Wood, elected Member, October 7th, 1908; died April 3d, 1911.

Alexander Ilich Wolkowyski, elected Junior, January 7th, 1908; died September 27th, 1910.

Adjourned.

FORTY-THIRD ANNUAL CONVENTION

Owing to the fact that the stenographer's report of the Annual Convention was not received in time for preparation for this number of *Proceedings,* the minutes of the meetings, report in full, etc., will be published in a subsequent number.

ELECTIONS AND TRANSFERS BY THE BOARD OF DIRECTION JUNE 30TH, 1911.

As Members

Henry Emmett Bartlett, Chicago, Ill.
Walter Freeman Brooks, Mankato, Minn.
Frank Foster, Buenos Aires, Argentine Republic.
Henry Webster Hobbs, Portland, Me.
William Hausmer Hoyt, Duluth, Minn.
William Henry Hunt, New York City.
George Craig Leidy, Steelton, Pa.
Samuel Osgood Miller, New York City.
Edward Stevens Rankin, Newark, N. J.
Henry Garnett Shirley, Towson, Md.
Edwin George Smith, Irwin, Pa.
William Thomas Walker, Chicago, Ill.

As Associate Members

Edward Ivan Clawiter, Denver, Colo.
Reginald George Clifford, Emigrant Gap, Cal.
Richard Sherman Cookinham, Twin Falls, Idaho.
Alexander Patton Crary, Corozal, Canal Zone, Panama.
Hans Andreas Daae, Sacramento, Cal.

LOUIS CHRISTIAN WILLIAM DATZ, New Orleans, La.
ERNEST HARTWELL ELDER, North Yakima, Wash.
CHARLES ALVIN EMERSON, JR., Harrisburg, Pa.
SAMUEL DAVIS FOSTER, Pittsburg, Pa.
THOMAS SLOAN HEWERDINE, Fisher, Ill.
BATTLE HARGROVE KLYCE, Americus, Ga.
GEORGE THOMAS MAWSON, Bombay, India.
FRED KNIGHTS MERRIMAN, Washington, D. C.
GEORGE FREDERICK MILES, New York City.
ARDSHIRE SORAB FRAMROZE MODY, Bombay, India.
GLENN LANE PARKER, Washington, D. C.
JOHN WILSON ROLAND, North Wilbraham, Mass.
CHARLES SAVILLE, Waban, Mass.
THOMAS SHACKELFORD SHEPPERD, Littleton, Colo.
WALTER DORR SMITH, Los Angeles, Cal.
WILLIAM BEAUVAIS SMITH, JR., New Orleans, La.
FELIX HENRY SPITZER, Kansas City, Mo.
ALBERT FRANKLIN STANFORD, Memphis, Tenn.
HENRY GROSVENOR THROOP, Syracuse, N. Y.
WILLIAM ALBIE VAN DUZER, Kittanning, Pa.
WILLIAM JULIUS WEIGMANN, Schenectady, N. Y.
HANSON ZIMRI WILSON, New York City.
ROBERT BROWN MURPHY WILSON, Empalme, Sonora, Mexico.
FRANK COY WOODWARD, East Pepperell, Mass.

AS JUNIORS

DOUGLAS ANTHONY ALLAIRE, Brooklyn, N. Y.
FREDERICK WEBBER AMADON, New Haven, Conn.
RAYMOND BOOTH, Culebra, Canal Zone, Panama.
ROSS JUDSON BUCK, Manila, Philippine Islands.
FOSTER BALDWIN CROCKER, Rome, N. Y.
WILLIAM AUGUSTINE CUNNINGHAM, Brooklyn, N. Y.
LORENZO JUAN DAVILA, Juana Diaz, Porto Rico.
LEWIS ALDEN ESTES, Detroit, Mich.
WARREN AUSTIN GATES, Oklahoma City, Okla.
GEORGE ELIAS HALSTEAD, New Albany, Ind.
GEORGE EDWARD HERCHKOVITZ, New York City.
WILLIAM HEYMAN, High Falls, N. Y.
LAURITZ RASMUS HJORTH, Seattle, Wash.
FERDINAND NORTHROP MENEFEE, Bend, Ore.
PERCY SHELLEY MONK, Newport, Ky.
STEPHEN EUGENE PAGE, Perth Amboy, N. J.
FLEMING KEEN RICH, Cedar Bluff, Va.
ROY ELMER SMITH, Seattle, Wash.

William Matthew Stieve, Cornwall-on-Hudson, N. Y.
John Strom, Champaign, Ill.
Arthur Cunningham Swift, Red Bank, N. J.

Transfers from Associate Member to Member

Charles Baker Burdick, Chicago, Ill.
Philip Burgess, Columbus, Ohio.
Richard Sanders Chew, San Francisco, Cal.
William Hugh Coverdale, New York City.
Elmore David Cummings, Baltimore, Md.
Christopher Columbus FitzGerald, Havana, Cuba.
Ernest Rotteck Gayler, Honolulu, Hawaii.
Thomas Monahan Lavelle, Pottsville, Pa.
Henry William Vehrenkamp, Cincinnati, Ohio.

Transfers from Junior to Associate Member

George Crowell Andrews, Fulton, N. Y.
Frank John Felgenhauer, Brooklyn, N. Y.
John Nathaniel Mackall, Baltimore, Md.
William Rogers Tyler, New York City.

OF THE BOARD OF DIRECTION

(Abstract)

June 6th, 1911.—President Endicott in the chair; Chas. Warren Hunt, Secretary, and present, also, Messrs. Belknap, Boller, Clarke, Flad, Kimball, Knap, Loomis, Macdonald, Ridgway, Snow, Strobel, Stuart, and Thompson.

A proposed change in the method of issue of the publications of the Society was presented by the Secretary and referred to the Publication Committee for report.

President Endicott and Messrs. Horace Loomis and Chas. Warren Hunt were appointed a Committee to arrange for the participation by this Society in the 12th International Congress of Navigation in 1912.

Action was taken in regard to members in arrears for dues.

Ballots for membership were canvassed, resulting in the election of 21 Members, 37 Associate Members, 1 Associate, and 20 Juniors, and the transfer of 13 Juniors to the grade of Associate Member, and 1 Junior to the grade of Associate.

Ten Associate Members were transferred to the grade of Member, and 1 Associate was transferred to the grade of Associate Member.

Applications were considered, and other routine business transacted.

Adjourned.

June 14th, 1911.—The Board met at the Hotel Patten, Chattanooga, Tenn., during the Annual Convention; President Endicott in the chair; Chas. Warren Hunt, Secretary; and present, also, Messrs. Bates, Bensel, Clarke, Courtenay, McDonald, and Ridgway.

No quorum being present, the Board adjourned.

June 30th, 1911.—A Special Meeting of the Board to canvass ballots for membership and to consider applications for membership was held at 5 P. M.; President Endicott in the chair; Chas. Warren Hunt, Secretary; and present, also, Messrs. Boller, Clarke, Kimball, Loomis, Ridgway, and Thompson.

Ballots for membership were canvassed resulting in the election of 12 Members, 29 Associate Members, and 21 Juniors, and the transfer of 4 Juniors to the grade of Associate Member.

Nine Associate Members were transferred to the grade of Member.

Applications were considered.

Adjourned.

ANNOUNCEMENTS

The House of the Society is open from 9 A. M. to 10 P. M., every day, except Sundays, Fourth of July, Thanksgiving Day, and Christmas Day.

FUTURE MEETINGS

September 6th, 1911.—8.30 P. M.—A regular business meeting will be held, and a paper by George B. Francis and Joseph H. O'Brien, Members, Am. Soc. C. E., entitled "The New York Tunnel Extension of the Pennsylvania Railroad: Certain Engineering Structures of the New York Terminal Area," will be presented for discussion.

This paper was printed in *Proceedings* for May, 1911.

September 20th, 1911.—8.30 P. M.—Two papers will be presented for discussion at this meeting, as follows: "Mule-Back Reconnaissances," by William J. Millard; Jun. Am. Soc. C. E., and "Economic Canal Location in Uniform Countries," by Lyman E. Bishop, Jun. Am. Soc. C. E.

Mr. Millard's paper was printed in *Proceedings* for May, 1911, and Mr. Bishop's paper is printed in this number of *Proceedings*.

October 4th, 1911.—8.30 P. M.—This will be a regular business meeting. A paper by Wilson Sherman Kinnear, M. Am. Soc. C. E., entitled "The Detroit River Tunnel," will be presented for discussion.

This paper is printed in this number of *Proceedings*.

October 18th, 1911.—8.30 P. M.—At this meeting a paper by George Gibbs, M. Am. Soc. C. E., entitled "The New York Tunnel Extension of the Pennsylvania Railroad: Station Construction, Road, Track, Yard Equipment, Electric Traction, and Locomotives," will be presented for discussion.

This paper was printed in *Proceedings* for May, 1911.

PROPOSED CHANGE IN METHOD OF SOCIETY PUBLICATIONS

The following suggestions of the Secretary have been presented to the Board of Direction and are now under consideration by the Board. This report was presented at the Business Meeting of the Annual Convention, June 14th, 1911, and is here reproduced as containing information which will be of interest to the membership.

To the Board of Direction,
American Society of Civil Engineers:

It has occurred to the Secretary that there would be many advantages if a change were made in the method of getting out our publications, and he has been investigating its possibilities for some time, and now brings the proposed plan to the attention of the Board in order that its essential features may be discussed sufficiently in advance of the possible time for putting it into practice, so that it may be decided upon, if the details can be worked out properly, or rejected as not wise on general principles.

Beginning with 1909, the *Transactions* have been issued in 4 volumes per annum (and there was an extra volume for 1910 which has not yet been issued). Each of these volumes contains on the average 550 to 600 pages.

The disadvantages of this system are:

(1) The great difficulty in closing up the discussion on a sufficient number of papers to make up the necessary number of pages for each volume and have it ready for issue quarterly.

(2) The time necessary to box, address, and mail each of these volumes (it now takes about 4½ weeks for each, or about one-third of the year for the four), which work must be done by the office force. This is rapidly becoming a burden as the edition increases.

(3) The cost of postage on the number of bound volumes (which now amounts to 3 700 out of a total edition of 6 300). On the average this is 25 cents per volume, or $1 per year, for each member who orders the binding.

(4) The cost for binding to each member, which is $4 per annum for half-morocco and $2 per annum for cloth, an average of $3, which, multiplied by the number of members who now secure binding, 3 700 = $11 100 per annum.

(5) The necessary limitation of the publication of discussions on any paper to one number of *Proceedings*. Because, if continued, discussions could not be closed in time for final publication in the quarterly volumes.

(6) When put upon the shelves, there are 4 separate indexes to look through to find a paper or discussion published in any one year.

Briefly, the scheme is to continue the publication of *Proceedings* as heretofore, but to publish only one volume of *Transactions* per annum, said volume to contain as much matter (as many pages, plates, etc.) as the four volumes now published.

This can be done by the use of thin "India," or, as it is sometimes called, "Bible" paper.*

The effect upon the disadvantages of the present system as stated above would be:

(1) The discussion on any paper need not be hurriedly closed, and could continue to be printed in *Proceedings* until all members have been heard from.

(2) The time necessary for boxing, mailing, etc., would be about one-quarter what it is now.

(3) The item of postage would be materially reduced, due to the difference in weight of paper and binding. With the present edition the saving would be about $1 500 and, of course, this saving would be increased rapidly as the edition increases.

(4) The direct individual saving to the Membership would be

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* With this report were submitted dummies of volumes containing, page for page, the 4 volumes issued in 1910. These are somewhat less than 2⅛ inches thick.

approximately $2 each for binding, which multiplied by the number of members who *now* secure binding, 3 700 = $7 400 total aggregate saving per annum. This is, of course, constantly increasing.

(5) The value of *Proceedings* would be increased by the publication therein of additional discussion and cross-discussion, and consequently they will be used more. In this connection, there should be added to each Number a Table of Contents covering the technical part from the beginning of each year to date.

(6) There would be one index covering the *Transactions* for each year instead of four.

(7) The space occupied on the shelf would be about four-tenths of that necessary for the four volumes.

The Secretary has talked of this suggested change with many members, and practically all have expressed approval of it. There have been a few mild objections advanced, for instance: One member said a volume of that size is hard to hold in the hand when reading—it must be placed on a table. Against this, one profoundly literary member, who has published many books, said, "Our present volumes are not thick enough to look dignified on the shelf."

It cannot be denied that the thin paper leaves are not so easy to turn when reading, and if this were a volume which is taken from the shelves to be read from cover to cover, there would be much to say against it, but it is really a book of reference, only consulted occasionally.

As to durability: investigation shows that, if anything, the thin paper stands the wear and tear of library use better than the thick. Almost all handbooks are on thin paper (usually not of as good quality as that proposed for our use), and they are more used than any other books in the Reading-room. They stand well.

The Secretary is not prepared to give definite figures as to the difference in cost of the two systems, but has gone far enough into this to be able to say that there will be very little, if any, additional expense, and that if the saving of postage, time of office force, as well as aggregate extra expense to Members for binding are considered, the result would in his opinion be in favor of the proposed change.

The Secretary has arranged with our printer to have 200 copies of the volume now going through the press struck off on this thin paper, which the binder will make up into 50 volumes (this representing fairly well the bulk of 4 volumes), binding some of these in half-morocco, some in cloth, and some in paper. We will then be able to see how the whole edition will look, and more accurate estimates of cost can be made by both printer and binder than have been possible to date.

Respectfully submitted,

CHAS. WARREN HUNT,
Secretary.

JUNE 6TH, 1911.

SEARCHES IN THE LIBRARY

In January, 1902, the Secretary was authorized to make searches in the Library, upon request, and to charge therefor the actual cost to the Society for the extra work required. Since that time many searches have been made, and bibliographies and other information on special subjects furnished.

The resulting satisfaction, to the members, who have made use of the resources of the Society in this manner, has been expressed frequently, and leaves little doubt that, if it were generally known to the membership that such work would be undertaken, many would avail themselves of it.

The cost is trifling compared with the value of the time of an engineer who looks up such matters himself, and the work can be performed quite as well, and much more quickly, by persons familiar with the Library.

In asking that such work be undertaken, members should specify clearly the subject to be covered, and whether references to general books only are desired, or whether a complete bibliography, involving search through periodical literature, is desired.

In reference to this work, the Appendices* to the Annual Reports of the Board of Direction for the years ending December 31st, 1906, and December 31st, 1910, contain summaries of all searches made to date.

PAPERS AND DISCUSSIONS

Members and others who take part in the oral discussions of the papers presented are urged to revise their remarks promptly. Written communications from those who cannot attend the meetings should be sent in at the earliest possible date after the issue of a paper in *Proceedings*. The issue of volumes of *Transactions* is dependent on the closing of discussions, and the co-operation of the membership in this matter is essential to the regular issue of each quarterly volume.

All papers accepted by the Publication Committee are classified by the Committee with respect to their availability for discussion at meetings.

Papers which, from their general nature, appear to be of a character suitable for oral discussion, will be published as heretofore in *Proceedings,* and set down for presentation to a future meeting of the Society, and, on these, oral discussions, as well as written communications, will be solicited.

All papers which do not come under this heading, that is to say, those which, from their mathematical or technical nature, in the opinion of the Committee, are not adapted to oral discussion, will not be scheduled for presentation to any meeting. Such papers will be published in *Proceedings* in the same manner as those which are to be presented at meetings, but written discussions, only, will be requested for subsequent publication in *Proceedings* and with the paper in the volumes of *Transactions.*

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* *Proceedings*, Vol. XXXIII, p. 20 (January, 1907); Vol. XXXVII, p. 28 (January, 1911).

SUBSCRIPTION PRICE TO THE PUBLICATIONS OF THE SOCIETY

The following subscription rates have been fixed by the Board of Direction for the publications of the Society:

Proceedings, ten Numbers per annum, $8. Price for single numbers, $1.

Transactions, four Volumes per annum, $12. Price for single volumes, $4.

On the above prices there is a discount of 50% to members who desire extra copies of any of these publications, and of 25% to Libraries and Book-dealers.

There is also an additional charge per annum, to cover foreign postage, of 75 cents for *Proceedings* and $1 for *Transactions,* or 8 cents and 25 cents, respectively, for single numbers.

A special subscription rate has been fixed by the Board for the *Proceedings* of the Society for the benefit of Students in Technical Schools. This rate is $4.50 per annum, and is available to any *bona fide* student of any technical school.

LOCAL ASSOCIATIONS OF MEMBERS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS

San Francisco Association

The San Francisco Association of Members of the American Society of Civil Engineers holds regular bi-monthly meetings, with banquet, and weekly informal luncheons. The former are held at 6 P. M., at the Palace Hotel, on the third Friday of February, April, June, August, October, and December, the last being the Annual Meeting of the Association.

Informal luncheons are held at 12.15 P. M. every Wednesday, and the place of meeting may be ascertained by communicating with the Secretary of the Association, E. T. Thurston, Jr., M. Am. Soc. C. E., 713 Mechanics' Institute, 57 Post Street.

The by-laws of the Association provide for the extension of hospitality to any member of the Society who may be temporarily in San Francisco, and any such member will be gladly welcomed as a guest of the Association at any of the above meetings, if he will notify the Secretary that he is in San Francisco.

Colorado Association

The meetings of the Colorado Association of Members of the American Society of Civil Engineers are held on the second Saturday of each month, except July and August. The hour and place of meeting are not fixed, but this information will be furnished on application to the Secretary, Gavin N. Houston, M. Am. Soc. C. E., 409 Equitable Building, Denver, Colo. The meetings are usually preceded by an informal dinner. Members of the American Society of Civil Engineers will be welcomed at these meetings.

Weekly luncheons are held on Wednesdays, and until further notice, will take place at The Colorado Traffic Club.

Visiting members are urged to attend the meetings and luncheons.

(Abstract of Minutes of Meeting)

May 27th, 1911.—The meeting was called to order; Vice-President Comstock in the chair; G. N. Houston, Secretary; and present, also, 27 members and 36 guests.

The minutes of the April meeting were read and approved.

President Anderson delivered a lecture on the Panama Canal, illustrating his remarks with lantern slides.

Adjourned.

PRIVILEGES OF ENGINEERING SOCIETIES EXTENDED TO MEMBERS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS

Members of the American Society of Civil Engineers will be welcomed by the following Engineering Societies, both to the use of their Reading Rooms and at all Meetings:

American Institute of Mining Engineers, 29 West Thirty-ninth Street, New York City.

Architekten=Verein zu Berlin, Wilhelmstrasse 92, Berlin W. 66, Germany.

Associação dos Engenheiros Civis Portuguezes, Lisbon, Portugal.

Australasian Institute of Mining Engineers, Melbourne, Victoria, Australia.

Boston Society of Civil Engineers, 715 Tremont Temple, Boston, Mass.

Brooklyn Engineers' Club, 117 Remsen Street, Brooklyn, N. Y.

Canadian Society of Civil Engineers, 413 Dorchester Street, West, Montreal, Que., Canada.

Civil Engineers' Society of St. Paul, St. Paul, Minn.

Cleveland Engineering Society, Chamber of Commerce Building, Cleveland, Ohio.

Cleveland Institute of Engineers, Middlesbrough, England.

Dansk Ingeniørforening, Amaliegade 38, Copenhagen, Denmark.

Engineers' and Architects' Club of Louisville, Ky., 303 Norton Building, Fourth and Jefferson Streets, Louisville, Ky.

Engineers' Club of Baltimore, Baltimore, Md.

Engineers' Club of Minneapolis, 17 South Sixth Street, Minneapolis, Minn.

Engineers' Club of Philadelphia, 1317 Spruce Street, Philadelphia, Pa.

Engineers' Club of St. Louis, 3817 Olive Street, St. Louis, Mo.

Engineers' Club of Toronto, 96 King Street, West, Toronto, Ont., Canada.

Engineers' Society of Northeastern Pennsylvania, 302 Board of Trade Building, Scranton, Pa.

Engineers' Society of Pennsylvania, 219 Market Street, Harrisburg, Pa.

Engineers' Society of Western Pennsylvania, 2511 Oliver Building, Pittsburg, Pa.

Institute of Marine Engineers, 58 Romford Road, Stratford, London, E., England.

Institution of Engineers of the River Plate, Buenos Aires, Argentine Republic.

Institute of Naval Architects, 5 Adelphi Terrace, London, W. C., England.

Junior Institution of Engineers, 39 Victoria Street, Westminster, S. W., London, England.

Koninklijk Instituut van Ingenieurs, The Hague, The Netherlands.

Louisiana Engineering Society, 321 Hibernia Bank Building, New Orleans, La.

Memphis Engineering Society, Memphis, Tenn.

Midland Institute of Mining, Civil and Mechanical Engineers, Sheffield, England.

Montana Society of Engineers, Butte, Montana.

North of England Institute of Mining and Mechanical Engineers, Newcastle-upon-Tyne, England.

Oesterreichischer Ingenieur= und Architekten=Verein, Eschenbachgasse 9, Vienna, Austria.

Pacific Northwest Society of Engineers, 803 Central Building, Seattle, Wash.

Rochester Engineering Society, Rochester, N. Y.

Sachsischer Ingenieur= und Architekten=Verein, Dresden, Germany.

Sociedad Colombiana de Ingenieros, Bogota, Colombia.

Sociedad de Ingenieros del Peru, Lima, Peru,

Societe des Ingenieurs Civils de France, 19 Rue Blanche, Paris, France.

Society of Engineers, 17 Victoria Street. Westminster, S. W., London, England.

Svenska Teknologforeningen, Brunkebergstorg 18, Stockholm, Sweden.

Tekniske Forening, Vestre Boulevard 18–1, Copenhagen, Denmark.

Western Society of Engineers, 1737 Monadnock Block, Chicago, Ill.

ACCESSIONS TO THE LIBRARY

(From May 8th to August 1st, 1911)

DONATIONS *

THE PRINCIPLES OF SCIENTIFIC MANAGEMENT.

By Frederick Winslow Taylor. Cloth, 9 x 6 in., 144 pp. New York and London, Harper & Brothers, 1911. $1.50.

The author states that it has been his object to point out the great losses sustained through inefficiency; to convince the reader that the remedy for this inefficiency lies in systematic management and not the man; to prove that the best management is founded on clearly defined laws, rules and principles which can be applied to any human activity; and to illustrate by examples the astounding results to be obtained by the application of these principles. The Contents are: Fundamentals of Scientific Management; The Principles of Scientific Management.

MUNICIPAL FRANCHISES.

A Description of the Terms and Conditions Upon Which Private Corporations Enjoy Special Privileges in the Streets of American Cities. By Delos F. Wilcox. Vol. II.—Transportation Franchises; Taxation and Control of Public Utilities. Cloth, 8 x 6 in., 21 + 885 pp. New York, The Engineering News Publishing Company, 1911. $5.00.

The first volume of this work, which was published in 1910, contained a general analysis of the subject and a description of typical municipal franchises in operation in the United States covering those utilities which are distributed by pipes or wires in the public streets, such as electric light and power, the telegraph, the telephone, etc. In this, the second volume, Part III is devoted to a description of local transportation franchises in a large number of American cities, namely, street railways, elevated railroads, subways, interurban railways, bridges, viaducts, toll roads, depots, belt line railroads, spur tracks, docks, markets, ferries, and omnibus lines. The author especially commends the chapter on "Elements of a Model Street Railway Franchise" to readers as containing important constructive suggestions. Part IV relates to a number of interesting and important items in the general franchise problem, such as the constitutional and statutory safe-guarding of franchise procedure, the regulation of public utilities by State and local commissions, franchise taxation, capitalization, and municipal ownership. The concluding chapters are stated to contain only a brief statement of what the author considers to be the more important general principles which should govern public activities in relation to the public utility problems considered therein. There is an Appendix containing the Minneapolis Gas Franchise passed February 23d, 1910, and the Minneapolis Gas Regulation Ordinance passed March 24th, 1910, which is followed by an extensive Index.

PRACTICAL SILO CONSTRUCTION.

By A. A. Houghton. (Concrete Worker's Reference Books, No. 3.) Paper, 7½ x 5 in., illus., 69 pp. New York, The Norman W. Henley Publishing Company, 1911. 50 cents.

This book is stated to contain complete data, working drawings, and specifications for the construction of concrete silos of any type, with illustrations of unpatented moulds and forms for monolithic and block silos. The Chapter headings are: The Concrete Silo; Requirements of a Silo; Size of Silo to Erect; Foundations for the Silo; Foundation with Floor Below Ground-Level; Forms for Monolithic Walls Without Air-Chamber; A Simple and Inexpensive Silo Form; Method of Raising Forms; Using Automatic Clamp; Plastered Silos; Concrete Block Silos; Concrete for Silo Work; Reinforcement of Silos; Doors for the Silo; Silo Roofs; Ornamental Roof or Wall for Silo; Index.

MOLDING CONCRETE CHIMNEYS, SLATE AND ROOF TILES.

By A. A. Houghton. (Concrete Worker's Reference Books, No. 4.) Paper, 7½ x 5 in., illus., 61 pp. New York, The Norman W. Henley Publishing Company, 1911. 50 cents.

In a secondary title, it is stated that this book is a practical treatise explanatory of the construction of block and monolithic types of concrete chimneys with

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* Unless otherwise specified, books in this list have been donated by the publishers.

easily constructed moulds for the same. The construction of monolithic concrete roofs, together with the moulding of concrete slate, roof tiles and slabs, is also discussed, and working drawings for the construction of an automatic tamping machine for moulding concrete slate with great rapidity, are included. The Contents are: Requisites of Chimney Construction; Constructing Small Monolithic Chimneys; Inter-locking Blocks for Small Concrete Chimneys; Ornamental Molds for Chimneys; Inter-locking Blocks for Large Chimneys; Forms for Large Monolithic Concrete Chimneys; Octagonal Monolithic Form; Various Types of Concrete Roofs; Monolithic Type of Concrete Roof; A Simple Bracket for Concrete Roof Construction; Molding an Ornamental Concrete Roof; Concrete Roof of Reinforced Slabs; Concrete Slate or Tile Roofs; Machine or Mold for Concrete Slate; Molding Hip, Ridge Roll, and Gable Ornaments; Preparing Plans for Roof Loads; Index.

MOLDING AND CURING ORNAMENTAL CONCRETE.

By A. A. Houghton. (Concrete Worker's Reference Books, No. 5.) Paper, 7½ x 5 in., illus., 58 pp. New York, The Norman W. Henley Publishing Company, 1911. 50 cents.

The various methods of moulding and curing ornamental concrete are here presented, it is stated, as the work would progress in practice. After describing the preparation of the moulds, the coating of the moulds to prevent sticking, and the various methods for filling them with the concrete mixture, the author explains the removal of the moulds and the repair of defects in the cast, as well as the various methods of surface treatment of the concrete and of curing the work. Detailed instructions are given for moulding imitation marble and granite, together with the proper proportions of cements and aggregates for use in the various finishes. The use of various coloring agents is explained, and instructions are included for making moulds for ornamental concrete, glue, wood, etc. The moulding of plaster patterns for use in making cast-iron moulds is also discussed.

CONCRETE MONUMENTS, MAUSOLEUMS AND BURIAL VAULTS.

By A. A. Houghton. (Concrete Worker's Reference Books, No. 6.) Paper, 7½ x 5 in., illus., 65 pp. New York, The Norman W. Henley Publishing Company, 1911. 50 cents.

In this volume the author describes the moulding of various types of concrete monuments, together with methods for constructing moulds for the same. The work of lettering and the placing of inscriptions is explained, as well as the cutting of ornamental designs in the concrete after it has been cured. Plans and designs for mausoleums and burial vaults are also given with complete details of construction.

MILITARY TOPOGRAPHY FOR THE MOBILE FORCES.

Including Map Reading, Surveying and Sketching. By Captain C. O. Sherrill, Corps of Engineers, U. S. Army. Second Edition. Cloth, 8¾ x 5¾ in., illus., 18 + 353 pp. Menasha, Wis., George Banta Publishing Co., 1911. $2.50. (Donated by the Author.)

The author states that the needs of the Military Service require, on the part of all its officers, a thorough knowledge of the uses and making of topographical maps of small areas, and the relation between the map and the ground, together with a practical knowledge of the making of topographical sketches at a rapid rate, so that the maps and sketches can be combined to show the entire front of a division at the end of each day's march. This book, it is stated, has been written with the intention of aiding the men to acquire this knowledge, and the hope is expressed that the methods described may also prove of value to beginners in the study of Civil Engineering, especially to those of limited mathematical training. All difficult mathematical discussion has been omitted, together with descriptions and methods of using obsolete and unnecessary surveying instruments. Part I, Military Map Reading, is said to be a statement of the principles and a solution of the problems essential to the accurate and rapid use of maps for military purposes, such as tactical map problems, war games, and maneuvers. A number of problems and their solutions are given, but these are said to be limited to such as have practical military value. Part I is stated to provide a complete reference book on Military Map Reading. In Part II, Military Topographical Surveying, the author describes methods of using surveying instruments, especially the plane table and stadia, as the best means of acquiring skill in estimating distances, slopes, and elevations, accurately. In Part III, Military Sketching, the methods used at the Army Service Schools in rapid military sketching are described in detail, especial emphasis being laid on practical methods of estimating distances, horizontal angles, slopes, and elevations. This book has been adopted as a textbook at the Army Service Schools at Fort Leavenworth, Kansas, at Garrison Schools for Officers, and at the Coast Artillery School at Fort Monroe, Virginia.

WHITTAKER'S ELECTRICAL ENGINEER'S POCKET BOOK.

Edited by Kenelm Edgcumbe. Third Edition, Revised. Cloth, 6½ x 4 in., illus., 8 + 597 pp. London and New York, Whittaker & Co., 1911. 5 shillings. (Donated by The Macmillan Company.)

Quoting from the preface to the first edition, the editor states that the Pocket Book will be found to contain a kind of synopsis of each subject given, brought up to date, and that owing to the great specialization which the rapid growth of electrical engineering has necessitated, it is of the utmost importance to know where to turn for reliable and up-to-date information, and he believes that this volume will fulfill this purpose, for while the various sections will be found to be sufficiently detailed for all ordinary requirements, copious references are given to various recent papers and publications containing full treatment of the subject in case further study is desired. These statements are said to apply to this, the third edition, a greater part of which has been re-written and every line of which has been checked for misprints and inaccuracies. The Contents are: Useful Numbers, etc.; Mathematics and Physics; Practical Mechanics; Electrical Tables; Magnetism; Electricity; Electrical Measuring Instruments; Electric Clocks; Electric Lighting; Secondary Batteries; Heavy Current Resistances; Direct Current Motors and Dynamos; Alternating Current Machines; Testing Generators, Motors and Transformers; Electrical Transmission of Power; Electric Traction; Switches and Switch-Gear; Electro-Metallurgy and Electro-Chemistry; Electric Power Stations and Mains; Legal Information; Index.

MONOPLANES AND BIPLANES.

Their Design, Construction and Operation: The Application of Aerodynamic Theory with a Complete Description and Comparison of the Notable Types. By Grover Cleveland Loening. Cloth, 8½ x 6 in., illus., 14 + 331 pp. New York, Munn & Company, Inc., 1911. $2.50.

The preface states that in this book the author has presented the subject of the aeroplane in a manner which he hopes will be intelligible and interesting to the average man as well as valuable to the more learned student. The subject-matter is divided into three parts. In Part I, after an historical introduction relating to the work of Langley, Lilienthal, and Chanute, the design of aeroplanes is discussed in a simple and thorough manner and the fundamental principles are explained, a complete example of the design of an aeroplane being given. Part II is devoted to detailed descriptions of the various successful types of monoplanes and biplanes, with photographs and diagrams. In Part III the leading types of monoplanes and biplanes are discussed and compared, and lines of probable future development are suggested. This part contains a chapter on the causes of fatal accidents which have occurred, and means of preventing such accidents are considered. The Contents are: Part I, The Design of Aeroplanes; Introduction; The Resistance of the Air and the Pressure on Normal Planes; Flat Inclined Planes; The Pressure on Curved Planes; The Frictional Resistance of Air; The Center of Pressure on Flat and Curved Planes; The Effect of Depth of Curvature and Aspect Ratio Upon the Lift and Drift of Curved Planes; Numerical Example of the Design of an Aeroplane. Part II, Detailed Descriptions of the Notable Aeroplanes; Introduction; Important Types of Monoplanes; Prominent Types of Biplanes. Part III, Comparison of the Types; Comparison of the Prominent Types; Controlling Apparatus; Accidents; The Variable Surface Aeroplane; Index.

GOOD ENGINEERING LITERATURE.

What to Read and How to Write, with Suggestive Information on Allied Topics. By Harwood Frost. Cloth, 8 x 5½ in., 12 + 422 pp. Chicago, The Author, 1911. $1.00.

The material contained in this book is stated to be a compilation and elaboration of addresses by the author, before engineering students, in the early part of 1910. It is intended, it is stated, as an aid to practicing engineers and engineering students in the making, selecting, and reading of engineering literature by outlining the application of the fundamentals of literary expression to special lines of work, by indicating how to collect, select, and arrange their information, and prepare it for publication, and by assisting the engineer in the selection and reading of his professional literature, and in the collection and preservation of information on various engineering subjects; in short, the book is intended to aid the engineer to speak and write clearly, to express his thoughts forcibly, and to describe his work so that others will understand it. In order to assist the writer in the preparation and marketing of his literary work, information is also given regarding the theory and practice of the publishing business. The Chapter Headings are: Literary Expression; Rhetoric and Grammar; Orthography and Punctuation; Words and Phrases; Inspiration and Motive in Literary Work; Essentials to Success in Literature; What to Write About; Collecting and Arranging Material; Exercising the Memory; Preparation of Manuscripts for Publication; "Field" and "Policy" of Technical Journals; The "Write-Up" Article; Rights of an Author in His Works; Copyright; Relations Between Author and Publisher; The Law of Libel; Preparation of Illustrations for Reproduction; The Making of a Book; Indexing and Filing; Literary Criticism; The Engineer's Library; List of Technical Indexes Appearing Serially; Index.

HISTORY OF BRIDGE ENGINEERING.

By Henry Grattan Tyrrell. Cloth, 9½ x 6¼ in., illus., 479 pp. Chicago, The Author, 1911. $4.00.

The author states that "proficiency in any art or science is not attained until its history is known," and that very little time or thought has been given to the History of Engineering by the Engineering Schools, the cause being attributed usually to dearth of literature on the subject. He therefore presents this book, stating that, while it is essentially the historical part of a comprehensive work on the subject, theory and method of design having been omitted purposely, the large number of illustrations should make it useful for reference, especially in selecting economic types of bridges and in preparing comparative designs and estimates. He has classified and described the various types of bridges, with the exception of movable bridges, from the earliest times, the greater part of the book being devoted, however, to bridges of the last century. The Contents are: Egyptian, Babylonian and Persian Bridges; Roman Bridges; Mediæval Bridges; Renaissance Bridges; Modern Stone Bridges; Pontoon Bridges; Aqueduct Bridges; Wooden Bridges; Cast Iron Bridges; Simple Truss Bridges; Tubular and Plate Girder Bridges; Suspension Bridges; Cantilever Bridges; Wrought Iron and Steel Arches; Trestles and Viaducts; Solid Concrete Bridges; Reinforced Concrete Bridges; Index.

CONSTRUCCIONES DE HORMIGON ARMADO.

Por Juan Manuel de Zafra. Primera Parte, Mecánica del Hormigón Armado. Paper, 9½ x 6½ in., illus., 8 + 292 pp. Madrid, V. Tordesilla, 1911. (Donated by the Author.)

The Chapter headings are: Idea General del Hormigón Armado; Resistencia y Elasticidad del Hormigón Armado; Cálculo en General, Cargas Uniformes; Flexión Sencilla; Flexión Compuesta; Cargas Transversales; Deformación y Solidaridad; Hormigón Zunchado; Apéndice.

TUBERCULOSIS HOSPITAL AND SANATORIUM CONSTRUCTION.

Written for the National Association for the Study and Prevention of Tuberculosis. By Thomas Spees Carrington. Cloth, 10½ x 7 in., illus., 164 pp. New York, The National Association for the Study and Prevention of Tuberculosis, 1911. 25 cents. (Donated by the Author.)

This work is an expansion of a pamphlet issued in 1909 by the Association and is intended as a guide in the design and construction of hospital and sanatorium buildings for the institutional care of tuberculous patients. The information contained herein is stated to have been collected during a series of investigations into the methods and materials used in the construction of buildings at various institutions for the treatment of patients with all varieties and in all the stages of tuberculous disease. The results of studies on the question of sites, to determine the effect of location and surroundings from both the clinical and economic points of view, are also included. The book contains many illustrations and plans of tuberculosis hospitals and sanatoria in various parts of the United States. The Contents are: Site and Grouping; Administration Buildings; Administration Buildings and Patients' Quarters Combined; Hospitals for Advanced Cases; Infirmaries and Reception Hospitals; Patients' Quarters: Lean-To Type of Building; Patients' Quarters: Cottage Type of Building; Illustrations.

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Mitteilungen über Forschungsarbeiten auf dem Gebiete des Ingenieurwesens, insbesondere aus den Laboratorien der technischen Hochschulen. Herausgegeben vom Verein deutscher Ingenieure. Heft 100. Julius Springer, Berlin, 1911.

An Elementary Manual of Statistics. By Arthur L. Bowley. Macdonald and Evans, London, 1910.

Handbuch der Ingenieurwissenschaften: Fünfter Teil. Der Eisenbahnbau: Ausgenommen Vorarbeiten, Unterbau und Tunnelbau. Von F. Loewe und H. Zimmermann. Siebenter Band. Zweite vermehrte Auflage. Wilhelm Engelmann, Leipzig, 1910.

Railway Station Service. By B. C. Burt. John Wiley & Sons, New York; Chapman & Hall, Limited, London, 1911.

The Principles of Handling Woodlands. By Henry Solon Graves. John Wiley & Sons, New York; Chapman & Hall, Limited, London, 1911.

Modern Methods of Water Purification. By John Don and John Chisholm. Edward Arnold, London, 1911.

Birdflight as the Basis of Aviation: A Contribution Towards a System of Aviation. By Otto Lilienthal, with a Biographical Introduction and Addendum by Gustav Lilienthal. Translated from the Second Edition, by A. W. Isenthal. Longmans, Green and Co., London, New York, Bombay and Calcutta, 1911.

Principles and Design of Aëroplanes. By Herbert Chatley. D. Van Nostrand Company, New York, 1911.

The Steam-Engine and Other Heat-Engines. By J. A. Ewing. Third Edition, Revised and Enlarged. University Press, Cambridge, 1910.

Who's Who in New York City and State: A Biographical Dictionary of Contemporaries. Fifth Biennial Edition. W. F. Brainard, New York, 1911.

Geology for Engineers. By R. F. Sorsbie. Charles Griffin & Company, Limited, London, 1911.

Report of the London Traffic Branch of the Board of Trade; 1908-09. Wyman and Sons, Ltd., London; Oliver & Boyd, Edinburgh; E. Ponsonby, Dublin, 1908-09.

The New International Year Book. A Compendium of the World's Progress for the Year 1910. Editor, Frank Moore Colby; Associate Editor, Allen Leon Churchill. Dodd, Mead and Company, New York, 1911.

The Royal Institute of British Architects: Town Planning Conference, London, 10–15 October, 1910: *Transactions.* The Royal Institute of British Architects, London, 1911.

Who's Who in America, Vol. VI, 1910-11: A Biographical Dictionary of Notable Living Men and Women of the United States. Edited by Albert Nelson Marquis. A. N. Marquis & Company, Chicago; Kegan Paul, Trench, Trubner & Co., Ltd., London.

Electric Power Plant Engineering. By J. Weingreen. McGraw-Hill Book Company, New York, London, 1910.

General Alphabetical and Analytical Index. *Transactions* of the American Institute of Mining Engineers, Vols. XXXVI–XL, 1905–1909. American Institute of Mining Engineers, New York, 1910.

Handbuch der Ingenieurwissenschaften: Dritter Teil. Der Wasserbau: Die Entwässerung der Städte. Von August Frühling. Vierter Band, Vierte, vermehrte Auflage. Wilhelm Engelmann, Leipzig, 1910.

Handbuch der Ingenieurwissenschaften: Dritter Teil. Der Wasserbau: Der Flussbau. Von Franz Kreuter. Sechster Band, Vierte, vermehrte Auflage. Wilhelm Engelmann, Leipzig, 1910.

The Aeroplane: Past, Present and Future. By Claude Grahame-White and Harry Harper. J. B. Lippincott Company, Philadelphia; T. Werner Laurie, London, 1911.

Dictionary of English and Spanish Technical and Commercial Terms Used Principally in the Iron, Steel, Hardware and Engineering Trades. By William Jackson. E. & F. N. Spon, Ltd., London; Spon & Chamberlain, New York, 1911.

The Practice of Copper Smelting. By Edward Dyer Peters. McGraw-Hill Book Company, New York and London, 1911.

Landscape Gardening: How to Lay Out a Garden. By Edward Kemp. Edited, Revised and Adapted to North America by F. A. Waugh. Fourth Edition. John Wiley & Sons, New York; Chapman & Hall, Limited, London, 1911.

Electric Crane Construction. By Claude W. Hill. Charles Griffin & Co., Limited, London; J. B. Lippincott Company, Philadelphia, 1911.

Railroad Traffic and Rates. By Emory R. Johnson and Grover G. Huebner. Vol. I, The Freight Service; Vol. II, Passenger, Express, and Mail Services. D. Appleton and Company, New York and London, 1911.

Encyclopedia Britannica, Vols. 1-14. Ed. 11. Cambridge University Press, Cambridge, England, 1910.

Handbuch der Ingenieurwissenschaften: Dritter Teil. Der Wasserbau: Landwirtschaftliche Bodenverbesserungen, Fischteiche, Flussdeiche, Seedeiche, Deichschleusen. Von J. Spöttle, P. Gerhardt, J. Wey, H. Garbe. Siebenter Band, Vierte, vermehrte und teilweise neu bearbeitete Auflage. Wilhelm Engelmann, Leipzig, 1911.

Forscherarbeiten auf dem Gebiete Eisenbetons. Heft 13-14. Wilhelm Ernst & Sohn, Berlin, 1911.

Inspection of the Materials and Workmanship Employed in Construction. By Austin T. Byrne. Third Edition, Revised. John Wiley & Sons, New York, 1911.

High Efficiency Electrical Illuminants and Illumination. By Rollin W. Hutchinson, Jr. John Wiley & Sons, New York, 1911.

Shade Trees in Towns and Cities. By William Solotaroff. John Wiley & Sons, New York, 1911.

Moody's Manual of Railroads and Corporation Securities, 1911. Twelfth Annual Number. Moody Manual Co., New York, 1911.

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(From May 8th to Aug. 1st, 1911)

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By purchase	49
Total	594

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Banks, Hugh Cunningham. Vice-Pres. and Chf. Engr., Pacific Rolling Mill Co., 908 Crocker Bldg., San Francisco, Cal		June 6, 1911
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Brooks, Walter Freeman. County Surv., Blue Earth County, Court House, Mankato, Minn		June 30, 1911
Burdick, Charles Baker. Hydr. and San. Engr., 1212 Hartford Bldg., Chicago, Ill	Assoc. M. M.	Mar. 1, 1905 June 30, 1911
Burgess, Philip. Hydr. and Chemical Engr. (Burgess & Long), 828 Cols. Savings and Trust Bldg., Columbus, Ohio	Assoc. M. M.	Nov. 7, 1906 June 30, 1911
Byers, Maxwell Cunningham. 871 Benton Ave., Springfield, Mo		June 6, 1911
Chew, Richard Sanders. 607 Humboldt Bank Bldg., San Francisco, Cal	Assoc. M. M.	Sept. 5, 1906 June 30, 1911
Cooley, Mortimer Elwyn. Prof. of Mech. Eng., and Dean, Dept. of Eng., Univ. of Michigan, Ann Arbor, Mich		May 2, 1911
Coverdale, William Hugh. Cons. Engr., 66 Broadway, New York City	Jun. Assoc. M. M.	Jan. 2, 1894 Oct. 3, 1900 June 30, 1911
Curtis, Varnum Pierce. Cons. Engr. and Contr., 96 Stafford St., Worcester, Mass	Assoc. M. M.	Dec. 7, 1904 May 2, 1911
Downs, Lawrence Aloysius. Asst. to Chf. Engr., M. of W., Ill. Cent. R. R., Fort Dodge, Iowa		Sept. 6, 1910
Fellows, Abraham Lincoln. Secy. and Gen. Mgr., The Field, Fellows & Hinderlider Eng. Co., 435 Century Bldg., Denver, Colo		June 6, 1911
Fessenden, Ralph Seth. Chf. Engr., Twin Falls-Raft River Land & Water Co., Rupert, Idaho		May 2, 1911

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Floy, Henry. Cons. Engr., 165 Broadway, New York City.		June 6, 1911
George, James Zachariah. Pres. and Chf. Engr., The George Constr. Co., 578 Randolph Bldg., Memphis, Tenn		Jan. 3, 1911
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Hedke, Charles Richard. Box 1106, Fort Collins, Colo.		June 6, 1911
Hodgkins, Henry Clarence. Cons. Engr., 514 Dillaye Bldg., Syracuse, N. Y		June 6, 1911
Hogue, Chester James. Constr. Engr., The Concrete Eng. Co., Paddock Bldg., Boston, Mass	Assoc. M. M.	Dec. 6, 1905 June 6, 1911
Howell, William Augustus. Engr., Streets and Highways, City Hall, Newark, N. J.	Assoc. M. M.	April 3, 1907 June 6, 1911
Hoyt, William Hausmer. Asst. Chf. Engr., Duluth, Missabe & Northern Ry., 401 Wolvin Bldg., Duluth, Minn		June 30, 1911
Hull, George Beckley. Asst. Engr., Dept. Public Works, Dominion of Canada, North Temiskaming, Que., Canada		May 2, 1911
Hunt, William Henry. Cons. Engr. (Duncan & Hunt), 29 Broadway, New York City		June 30, 1911
Hunter, Adam. Chf. Engr. and Director, *Sir* William Arrol & Co., Ltd., 85 Preston St., Bridgeton, Glasgow, Scotland	Assoc. M. M.	Sept. 6, 1905 May 2, 1911
Hyde, Howard Elmer. Engr. in Chg., Design, Havana Sewerage and Drainage Systems. Alcantarillado, Cuba 24, Havana, Cuba	Assoc. M. M.	April 4, 1906 June 6, 1911
Johnson, Ben. Supt. of Locks, Gatun, Canal Zone, Panama		June 6, 1911
Kurashige, Tetsuzo. Chf. Hydrographer, Home Dept., Tokyo, Japan		May 2, 1911
Lavelle, Thomas Monahan. Engr. with The Eastern Steel Co., Pottsville, Pa	Assoc. M. M.	Sept. 7, 1904 June 30, 1911
Lee, Frank. Div. Engr., Canadian Pacific Ry., Winnipeg, Man., Canada		May 2, 1911
Lehman, George Mustin. Engr. in Chg. for Eng. Committee, Flood Comm. of Pittsburg, 1804 Arrott Bldg., Pittsburg, Pa		May 2, 1911
Leighton, Marshall Ora. Chf. Hydrographer, U. S. Geological Survey (Res., 1759 Lanier Pl.), Washington, D. C.	Assoc. M. M.	Oct. 4, 1905 Feb. 28, 1911

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OKESON, WALTER RALEIGH. Res. Engr., Phœnix Bridge Co., also Phœnix Iron Co., 49 William St., New York City		June 6, 1911
RABELLO, CESAR DE SÁ. Technical Director, Companhia Brazileira de Energia Electrica, P. O. Box 883, Rio de Janeiro, Brazil		June 6, 1911
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SHIRLEY, HENRY GARNETT. Roads Engr., Baltimore County, Towson, Md.		June 30, 1911
THOMPSON, WILLIAM LOVE. Asst. Engr., Isthmian Canal Comm., Corozal, Canal Zone, Panama		June 6, 1911
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TRESISE, FRANCIS JOHN. Pres. and Mgr., Erie Contr. Co., 400 D. S. Morgan Bldg., Buffalo, N. Y.		June 6, 1911
VAN LOAN, SETH MORTON. First Asst. to Chf., Bureau of Water, Room 790, City Hall, Philadelphia, Pa.	Jun. Assoc. M. M.	Dec. 28, 1900 Oct. 7, 1903 May 2, 1911
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WALKER, WILLIAM THOMAS. Care, H. M. Byllesby & Co., 218 La Salle St., Chicago, Ill.		June 30, 1911
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	Assoc.	Nov. 3, 1903
	Assoc. M.	Nov. 1, 1904
	M.	June 6, 1911
Winsor, George Alpha. P. O. Box 60, Valhalla, N. Y.		June 6, 1911
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Andrews, George Crowell. Asst. Engr. in Chg., Contract 10, New York State Barge Canal, Fulton, N. Y.	Jun.	Aug. 31, 1909
	Assoc. M.	June 30, 1911
Arledge, Arthur Edward. Box 615, Honolulu, Hawaii		May 2, 1911
Axtell, Frank Foy. U. S. Junior Engr., Port Arthur, Tex.		June 6, 1911
Bailey, Charles Lester. Care, U. S. Reclamation Service, Augusta, Mont.		May 2, 1911
Bixby, Frederick Louis. Prof. of Civ. and Irrig. Eng., and Irrig. Engr., Agricultural Experiment Station, Agricultural College, N. Mex.		June 6, 1911
Bouillon, Arthur Maximillien. Dist. Engr., Grand Trunk Pacific Ry., P. O. Box 82, St. John, N. B., Canada		June 6, 1911
Brainard, Albert Sereno. (Alderson & Brainard), 49 Pearl St., Hartford, Conn.	Jun.	Oct. 6, 1908
	Assoc. M.	June 6, 1911
Brown, Grover Charles. Care, Enrique Ruiz Williams, Solis 72, Sagua la Grande, Cuba	Jun.	June 2, 1908
	Assoc. M.	May 3, 1911
Bushnell, Howard Emory. Contr. Engr., Levering & Garrigues Co., 808 Firemans Ins. Bldg., Newark, N. J.	Jun.	Mar. 6, 1906
	Assoc. M.	June 6, 1911
Church, Hartley Robert. 3031 Benvenue Ave., Berkeley, Cal.		June 6, 1911
Claflin, Fred Winslow. Res. Engr. and Supt. of Constr., Quemahoning Dam, R. F. D. No. 1, Holsopple, Pa.		June 6, 1911
Clark, Arthur Pierson. Asst. Chf. Engr., Corrugated Bar Co., 1410 Bank of Commerce Bldg., St. Louis, Mo.		Dec. 6, 1910
Clawiter, Edward Ivan. (Hampson-Fielding Eng. Co.), 1711 Wazee St., Denver, Colo.		June 30, 1911

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Comstock, Arthur Francis. 72 Altruria St., Buffalo, N. Y		April 4, 1911
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Crary, Alexander Patton. Junior Engr., Isthmian Canal Comm., University Club, Ancon, Canal Zone, Panama.		June 30, 1911
Crocker, James Roger. Cons. Engr., McDonald Electrolytic Co., 202 West 79th St., New York City		June 6, 1911
Daae, Hans Andreas. Contr. Engr., Clark & Henery Constr. Co., 515 Ochsner Bldg., Sacramento, Cal		June 30, 1911
Datz, Louis Christian William. Care, Ford, Bacon & Davis, 921 Canal St., New Orleans, La		June 30, 1911
Dawson, Jay Bosworth. P. O. Box 51, Sta. C, Los Angeles, Cal		June 30, 1910
Dessery, Floyd Gossett. (Dessery & West), 1117 Union Trust Bldg., Los Angeles, Cal		Feb. 28, 1911
Dobson, Gilbert Colfax. Gatun, Canal Zone, Panama		May 2, 1911
Doolittle, Harold James. City Engr., 313 North Naches, North Yakima, Wash		June 6, 1911
Edmondson, Ralph Selden. Asst. Engr., Board of Water Supply, City of New York, High Falls, N. Y		June 6, 1911
Elder, Ernest Hartwell. Office Engr., C. H. Swigart, Box 1175, North Yakima, Wash		June 30, 1911
Ellstrom, Victor Edwin. St. Louis Representative and Structural Engr., Bethlehem Steel Co., 1015 Chemical Bldg., St. Louis, Mo		Dec. 6, 1910
Emerson, Charles Alvin, Jr. Prin. Asst. Engr., Pennsylvania Dept. of Health, Harrisburg, Pa		June 30, 1911
Felgenhauer, Frank John. Chf. Engr., E. Felgenhauer's Sons (Res., 1439 Dean St.), Brooklyn, N. Y	Jun. Assoc. M.	May 4, 1909 June 30, 1911
Gass, Elmer John. P. O. Box 459, Everett, Wash		Dec. 6, 1910
Gaston y Rosell, Francisco José. Engr. in Chg., Dredging Work, Isabela de Sagua Harbor, Isabela de Sagua, Cuba		June 6, 1911
Gibbs, Nathan Jackson. Supt., Tomkins Cove Stone Co., Tomkins Cove, N. Y		May 2, 1911
Gilman, Charles. 1228 Lenox Ave., Plainfield, N. J	Jun. Assoc. M.	Dec. 6, 1904 June 6, 1911
Golding, Thomas Wund. 8654 Nineteenth Ave., Brooklyn, N. Y		Jan. 31, 1911

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Heslop, Derwent Gordon. Res. Engr., Canton-Hankow Ry., Care, Imperial Post Office, Shiuchow-Fu, Kwangtung, South China		May 2, 1911
Hewerdine, Thomas Sloan. Box 161, Fisher, Ill		June 30, 1911
Hoard, Clarence. Chf. Engr., Victoria & Barkley Sound Ry., P. O. Box 216, Victoria, B. C., Canada		Feb. 28, 1911
Hosmer, Ralph Herbert. 711 Telegraph Bldg., Harrisburg, Pa		Dec. 6, 1910
Hutchings, John Bacon, Jr. Room 114, Eng. Hall, Univ. of Illinois, Urbana, Ill	Jun. Assoc. M.	Sept. 6, 1904 May 2, 1911
Jacobosky, Gilbert Garfield. Cons. Engr., 116 Second National Bank Bldg., Wilkes-Barre, Pa	Jun. Assoc. M.	Nov. 5, 1907 June 6, 1911
Jones, Grandville Reynard. Chf. Chemist and Asst. Supt., Washington Aqueduct Filtration Plant, Washington, D. C.	Jun. Assoc. M.	Jan. 7, 1908 May 2, 1911
Keller, Arthur Ripont. Prof. of Civ. Eng., Coll. of Hawaii, Honolulu, Hawaii		June 6, 1911
Kern, Joseph Francis. 716 Decatur St., Brooklyn, N. Y.		April 4, 1911
Klyce, Battle Hargrove. Box 240, Americus, Ga		June 30, 1911
Kuehnle, William Louis. U. S. Junior Engr., Room 710, Army Bldg., New York City		June 6, 1911
Mackall, John Nathaniel. Chf. Draftsman, State Roads Comm. of Maryland, Baltimore, Md	Jun. Assoc. M.	Aug. 31, 1909 June 30, 1911
Macredie, John Robert Clarke. Asst. Engr. in Chg. of Viaduct, Canadian Pacific Ry., Box 72, Outlook, Sask., Canada		Feb. 28, 1911
McClure, Guy Vincent. City Engr., 800 Insurance Bldg., Oklahoma City, Okla		April 4, 1911
McDermith, Oro. Asst. Engr., U. S. Reclamation Service, Newell, S. Dak		June 6, 1911
McGlathery, Sam Lyon. Asst. Engr., Bureau of Public Works, Manila, Philippine Islands		Feb. 28, 1911
Merriman, Fred Knights. Instr., Civ. Eng. Dept., Catholic Univ. of America, Washington, D. C		June 30, 1911
Miles, George Frederick. Cons. Efficiency Engr., 108 Worth St., New York City		June 30, 1911
Moody, Clare Joseph. Asst. Engr., U. S. Reclamation Service, Ronan, Mont		June 6, 1911

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Packard, Daniel Berry. City Engr., Washington, N. C.		June 6, 1911
Reinhardt, Jacob Brunn. Res. Engr., N. Y. C. R. R., 110 Shepard St., Rochester, N. Y		May 2, 1911
Riggs, Charles Albert. Chf. Draftsman, J. A. Stewart and Cin. Union Depot & Terminal Co., 540 East 3d St., Newport, Ky		June 6, 1911
Roake, Stephen Allen. Asst. Engr., Am. Bridge Co., 105 North Gouverneur Ave., Trenton, N. J		June 6, 1911
Robson, Frederick Thurston. Cons. and Superv. Engr. (Sloan & Robson), 802 Nevada Bank Bldg., San Francisco, Cal		June 6, 1911
Scheidenhelm, Frederick William. Cons. Engr. for James B. Hogg, 801 Second National Bank Bldg., Connellsville, Pa		June 6, 1911
Seaman, William Henry. County Supt. of Highways, Nassau County, Glen Cove, N. Y		June 6, 1911
Shafer, James Charles Forsythe. Res. Engr. for Truesdell-Fox Co. of New York City, Hadlock, Wash	Jun. Assoc. M.	Oct. 6, 1908 May 2, 1911
Shema, Joseph. Insp. of Bridges, B. & O. R. R., B. & O. Station, Room 326, Wheeling, W. Va	Jun. Assoc. M.	Oct. 3, 1905 June 6, 1911
Shepperd, Thomas Shackelford. Cons. and Contr. Engr., Littleton, Colo		June 30, 1911
Shoemaker, John Earl. Designing and Constr. Engr., Pueblo-Rocky Ford Irrig. Co., 601 North Main St., Pueblo, Colo		June 6, 1911
Skorniakoff, Eugene Eugenievich. Dept. of Irrig., Ministry of Agriculture, St. Petersburg, Russia		May 2, 1911
Smith, Edward St. Clair. City Engr., Gooding, Idaho		Dec. 6, 1910
Smith, William Beauvais, Jr. U. S. Junior Engr., U. S. Engr. Office, Custom House, New Orleans, La		June 30, 1911
Squire, Harry Edwin. Engr. for Erickson Constr. Co., 924 Highland Ave., Bremerton, Wash	Jun. Assoc. M.	Jan. 3, 1907 June 6, 1911
Stegner, Clifford Milton. Engr., Dept. of Bldgs., City Hall, Cincinnati, Ohio		May 2, 1911
Stellhorn, Adolf. Civ. Engr., War Dept., U. S. A., 1312 South 2d St., Leavenworth, Kans		May 2, 1911

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Swanitz, Henry Wade. 1390 Seventh Ave., San Francisco, Cal.		May 2, 1911
Throop, Henry Grosvenor. Engr. of Constr. and Record, Oneida Ry. Co., Utica & Mohawk Val. Ry. Co., and Syracuse Rapid Transit Ry. Co., 1608 South Geddes St., Syracuse, N. Y.		June 30, 1911
Van Duzer, William Albie. Res. Engr., Pitts. & Shaw. R. R., R. D. No. 5, New Bethlehem, Pa.		June 30, 1911
Van Hagan, Leslie Flanders. Room 304, Engineering Bldg., Univ. of Wisconsin, Madison, Wis.		June 6, 1911
Wall, George Albert. Asst. Engr., C. P. I. D., Bassano, Alta., Canada		Jan. 3, 1911
Weigmann, William Julius. Asst. Engr., New York State Barge Canal, 4 Elmer Ave., Schenectady, N. Y.		June 30, 1911
Weston, Frederick Sampson. Middleboro, Mass.	Jun. Assoc. M.	Oct. 5, 1909 June 6, 1911
Whittet, Rufus Mason. Asst. Engr., Massachusetts State Board of Health, Room 141, State House, Boston, Mass.		May 2, 1911
Wickham, Harry Rogers. Asst. Engr., Dept. State Engr. and Surv., Chg., Contract 23, 19 Meigs St., Rochester, N. Y.		June 6, 1911
Williams, James Henry. Supt. of Dam and Water Supply Work, Ft. Meade, S. Dak.		June 6, 1911
Wilson, Hanson Zimri. Engr., Standard Oil Co., 29 Broadway, Room 1700, New York City		June 30, 1911
Wilson, Robert Brown Murphy. Engr., M. of W., Ferrocarril Sud-Pacifico de Mexico, Ferrocarril de Sonora, Empalme, Sonora, Mexico		June 30, 1911
Wright, Otis Hord. Asst. Engr., Water Board, 452 Ainsworth Ave., Portland, Ore.		May 2, 1911

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Brown, William Alden. Mgr., Mfg. Dept., Burham Portland Cement Works, Burham, Kent, England		May 2, 1911
Dilworth, Edward Coe. 5806 Howe St., Pittsburg, Pa.		June 6, 1911
Moran, Robert Breck. 519 California St., San Francisco, Cal.	Jun. Assoc.	Sept. 1, 1908 June 6, 1911
Price, Charles Pearl. Mgr., American Tar Co., 201 Devonshire St., Boston, Mass.		May 2, 1911

JUNIORS

	Date of Membership.
ALLAIRE, DOUGLAS ANTHONY. 2265 Eighty-fourth St., Brooklyn, N. Y.	June 30, 1911
BEALL, PENDLETON. 20 Cannon St., Poughkeepsie, N. Y.	June 6, 1911
BRANN, EMMETT RAYMOND. Care, The Texas Co., Tulsa, Okla.	Dec. 6, 1910
BRINGHURST, JOHN HENRY. 3402 Milam St., Houston, Tex.	Jan. 3, 1911
DAVIS, DANIEL ELIAS. Asst. City Engr., Alliance, Ohio.	Feb. 28, 1911
ESTES, LEWIS ALDEN. Asst. of Mgr., Foreign Trade Dept., The Trussed Concrete Steel Co., Detroit, Mich.	June 30, 1911
GATES, WARREN AUSTIN. Structural Engr., Leighton & Smith, 701 Majestic Bldg., Oklahoma City, Okla.	June 30, 1911
HALSTEAD, GEORGE ELIAS. Asst. Engr., Kentucky & Indiana Terminal R. R., 2019 Ekin Ave., New Albany, Ind.	June 30, 1911
HAVENS, WILLIAM WESTERFIELD. 469 East 134th St., New York City.	Dec. 6, 1910
HUBBARD, DANIEL. 1407 Mt. Royal Ave., Baltimore, Md.	Dec. 6, 1910
HUGHES, NORMAN. 345 Arcade Bldg., Norfolk, Va.	Dec. 6, 1910
HUTCHINS, EVERETT NELSON. Care, Board of Water Supply, High Falls, N. Y.	Jan. 31, 1911
JOHNSON, FRANK MELVIN. 1303 East Marion St., Seattle, Wash.	Jan. 31, 1911
MACY, FRANK HENRY. Care, State Water Supply Comm., Albany, N. Y.	Jan. 3, 1911
MCCAFFREY, JOHN WILLIAM. Draftsman, Taft-Peirce Mfg. Co., 17 Spring St., Woonsocket, R. I.	Jan. 31, 1911
MCKEAN, HARRY PARKER. Res. Engr. and Mgr., The Otero Irrig. Dist., 3 McNeen Bldg., La Junta, Colo.	June 6, 1911
MENEFEE, FERDINAND NORTHROP. Bend, Ore.	June 30, 1911
PAGE, STEPHEN EUGENE. Box 21, Perth Amboy, N. J.	June 30, 1911
PAYNE, JAMES ELWOOD. Dist. Engr., New York Office, Corrugated Bar Co., 17 Battery Pl., New York City.	June 6, 1911
SMITH, GEORGE WASHINGTON. Care, Supt. of Bldg. Constr., Canadian Pacific Ry., Montreal, Que., Canada.	Jan. 31, 1911
SNYDER, HUBERT EARL. Concrete Foreman, Isthmian Canal Comm., Gatun, Canal Zone, Panama.	May 2, 1911
SPENGLER, JOHN HENRY. 2347 Fifteenth St., Troy, N. Y.	June 6, 1911
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VANDEVANTER, ELLIOTT. Engr. in Chg., Cost Keeping, Claiborne, Johnston & Co., 901 Calvert Bldg., Baltimore, Md.	June 6, 1911
WARD, ROY ELSEN. Box 427, Massena, N. Y.	May 2, 1911

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WHEATCROFT, HENRY BELCHER, JR. 438 West 57th St., New York City	June 6, 1911
WHITMAN, WILLIAM SATTERWHITE. Care, Chf. Engr., L. & N. R. R., Louisville, Ky	May 2, 1911
YOUNG, OLIVER EARLE. U. S. Junior Engr., R. F. D. No. 1, Lincoln, Ala	June 6, 1911

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TAYLOR, JACKSON, JR. Swarthmore, Pa.

TEIGEN, THOMAS WILLIAM ROSTAD. Engr., Gorge Terminal, Mexico North Western Ry., Madera, Chihuahua, Mexico.

ASSOCIATE MEMBERS (*Continued*)

Thomas, William Edward. Asst. Engr., L. I. R. R., The Anchorage, Port Washington, N. Y.

Tibbetts, Frederick Horace. (Haviland & Tibbetts), Alaska Commercial Bldg., San Francisco, Cal.

Tilmont, Paul Alphonse Gaillard. Track and Ballast Engr., N. P. Ry., Box 482, Kelso, Wash.

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Tucker, Herman Franklin. Kendal Green, Mass.

Tull, Richard William. Asst. Engr., Eastern Steel Co., 60 Broadway, New York City.

Turley, Omner Jay. Turley, N. Mex.

Turner, Augustus Miesse. Res. Engr., C., C., C. & St. L. Ry. Co., Sharonville, Ohio.

Vogt, John Henry Leon. R. F. D. No. 1, Box 170, San Diego, Cal.

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Wassner, Michael. Care, Caribbean Constr. Co., Cape Haitien, Haiti.

Williamson, Charles Sumner. Care, Mead-Morrison Mfg. Co., Monadnock Bldg., Chicago, Ill.

Wilson, Harry Percival. Care, W. F. Kearns Co., 240 Albany St., Cambridgeport, Mass.

Wolcott, Christopher Stanton. The Kirkland, Kingston, N. Y.

Yates, Eugene Adams. Supt., MacArthur Bros. Co., 644 Brown Marx Bldg., Birmingham, Ala.

Yates, William Henry. Superv. Engr., Barge Canal, Barge Canal Office, Albany, N. Y.

ASSOCIATES

Lally, John Michael. Asst. Supt. of Constr., Grand Central Terminal Impvt., N. Y. C. & H. R. R. R., 63 Dock St., Yonkers, N. Y.

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Wrenn, James Francis. Gen. Supt. of Constr., for Jno. B. Carter Co., Box 461, Fayetteville, N. C.

JUNIORS

Abrons, Louis William. Care, Rutland Mfg. Co., Rutland, Vt.

Ackerman, Arthur Pope. Great Barrington, Mass.

Adey, John Seager. Care, Rockwood Sprinkler Co., 134 South LaSalle St., Chicago, Ill.

Ashbrook, Chester Daniel. Chatcolet, Idaho.

Atwood, Chester Ely. Valier, Mont.

Barker, Ludlow Osmond, Jr. U. S. Engr. Office, New Cumberland, W. Va.

JUNIORS (*Continued*)

Battie, Herbert Scandlin. Box 126, Harrisburg, Pa.

Beard, Vivian Dangerfield. Ambridge, Pa.

Boig, Alexander Fletcher. Care, Am. Bridge Co., Ambridge, Pa.

Bolton, Frank Leonard. 800 Cutler Bldg., Rochester, N. Y.

Brooks, Josiah Richardson. Care, Tom's Harbor Camp, Long Key, Fla.

Burnham, George Earle. Care, Manila Ry. Co., Manila, Philippine Islands.

Burpee, George William. With MacKenzie, Mann & Co., Ltd., Merivale, Ont., Canada.

Bushway, Walter Benjamin. Asst. Engr., Boston Elev. Ry. Co., 69 Bradford Ave., Roslindale, Mass.

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Chester, Charles Porter. With Stone & Webster Eng. Corporation, Burleson, Tex.

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Cochran, Jerome. Designing Engr., Trussed Concrete Steel Co., Trussed Concrete Bldg., Detroit, Mich.

Coleman, Lester Lyman. Maricopa, Kern Co., Cal.

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Day, Warren Ellis. Care, Wright Contract Co., Enumclaw, Wash.

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Drake, Ralph Edmund. Barge Canal Office, Seneca Falls, N. Y.

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Ellis, Herbert Cram. Care, White Plains Club, White Plains, N. Y.

Flick, John Kramer. Loch Raven, Md.

Gilland, Thomas Omar. Windber, Pa.

Gillespie, Chester Gordon. Hollister, Cal.

Graham, John William. Acting Dist. Engr., Province of Misamis, Cagayan, Misamis, Philippine Islands.

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JUNIORS (*Continued*)

Huff, Walter William. Box 74, Sullivan, Ill.

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Jordan, Myron Kendall. With H. S. Crocker, Cons. Engr., 308 Tramway Bldg., Denver, Colo.

Joslin, Harold Vincent. Care, F. W. Abbot, Constr. Mgr., Yadkin River Power Co., Pee Dee, N. C.

Kellersberger, Arnold Charles. Mech. and Civ. Engr., 1700 New York, Fort Worth, Tex.

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Littlefield, Emmett. 13 Monroe Court, Troy, N. Y.

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Malsbury, Omer Evert. Junior Engr., I. C. C., Culebra, Canal Zone, Panama.

Manzanilla y Carbonell, José Justo. Care, Huston Trumbo Dredging Co., Isabela de Sagua, Santa Clara, Cuba.

Marsh, Charles Reed. Supt. of Constr., U. S. Public Bldgs., Treasury Dept.; Supt. of Constr., U. S. P. O., Ionia, Mich.

Maxwell, Donald Hebard. Asst. Engr., Alvord & Burdick, 1417 Hartford Bldg., Chicago, Ill.

Merriman, Richard Mansfield. Dept. of the Interior, San Juan, Porto Rico.

Moore, James Gates. Res. Engr., Florida Coast Line Canal & Trans. Co., West Palm Beach, Fla.

Murphy, James Francis. Asst. Engr., Board of Water Supply, 1996 Madison Ave., New York City.

Nagel, Theodore. (Nagel & Peterson), 514 Equity Bldg., Muskogee, Okla.

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Paine, George Hebard. Neenah, Wis.

Paret, John Waldo. Care, Wichita Falls & Northwestern Ry., Trail, Okla.

Parlin, Raymond Washington. Res. Engr., Washington County Water Co., 116 West Washington St., Hagerstown, Md.

Paterson, Charles Judson. Care, The Republic Structural Iron Works Co., Cleveland, Ohio.

JUNIORS (*Continued*)

PATTERSON, IRVING WOOSTER. Highway Constr. Engr., The Texas Co., 8 Patterson Court, Waterville, Conn.

PORTER, HARRY FRANKLIN. 1157 Park Ave., Bridgeport, Conn.

QUERBACH, EARL. Draftsman, Am. Bridge Co., Ambridge (Res., 201 California Ave., Avalon), Pa.

RAMSER, CHARLES ERNEST. Alma, Ill.

RATHBUN, JOHN CHARLES. Colfax, Wash.

REED, CARL SWEETLAND. Western Representative, Am. Locomotive Co., 907 McCormick Bldg., Chicago, Ill.

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RUSSELL, ALEXANDER STUART. Care, Standard Oil Co., El Segundo Refinery, Box 175, Los Angeles, Cal.

SAXE, VAN RENSSELAER POWELL. Asst. Engr. for Standard Concrete Steel Co., 415 East 31st St., New York City (Res., 16 Van Houten Pl., Belleville, N. J.).

SCOTT, WALTER VANDERBELT. Care, H. M. Beckwith, East Rochester, N. Y.

SEGUR, ASA BERTRAND. Dist. Mgr., Cheboygan Realty Co., 21 Prixly Long Bldg., Fort Wayne, Ind.

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SOO-HOO, PETER. 312 East 14th St., Kansas City, Mo.

STEWART, WALTER PHELPS. U. S. Junior Engr., U. S. Engr. Office, Custom House, Louisville, Ky.

STOCKER, EDWARD CHARLES. Instr. in Civ. Eng., Univ. of Colorado, 302 West Wilson, Madison, Wis.

STONE, JAMES HAMMOND. Engr. in Chg. of Constr., Carretera del Oeste, Care, H. F. D. Burke, Director-Gen., Santo Domingo, Santo Domingo.

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TEAL, JONATHAN ERNEST. Asst. Div. Engr., Mo. Pac. Ry. Co., Van Buren, Ark.

TILLSON, EDWIN DELEVAN. Supt., Dodge, Day & Zimmermann, Altoona, Pa.

TINGLEY, FRANCIS. Care, Seybolt Corsa, R. F. D. No. 1, Walden, N. Y.

TOLL, ASAHEL CLARK. Bayamon, Porto Rico.

TURNER, CHARLES RUSSELL. U. S. Deputy Mineral Surv., 1012 Lawrence Ave., Chicago, Ill.

TYLER, RICHARD GAINES. Instr. in Civ. Eng., Univ. of Texas, Care, University Sta., Austin, Tex.

TYLER, WILLIAM ROGERS. With Ruggles-Robinson Co., Contrs., 331 Madison Ave., New York City.

VEATCH, NATHAN THOMAS, JR. Asst. Engr., State Board of Health, 209 Engineering Bldg., Lawrence, Kans.

JUNIORS (*Continued*)

VOGEL, JOHN LEONARD. Chf. Engr.'s Office, C. R. R. Co. of N. J., New York City.

WEBER, DANIEL RISHEL. Box 36, Caliente, Nev.

WILBANKS, JOHN ROBERT. 630 Southern Trust Bldg., Little Rock, Ark.

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WILMOT, JAMES. Hazelhurst, Miss.

WILMOT, SYDNEY. Topographic Draftsman, Isthmian Canal Comm., Culebra, Canal Zone, Panama.

WILSON, WILLIAM WEST. Care, Canadian Stewart Co., Ltd., Jonquieres, Que., Canada.

WINCHESTER, THOMAS HARRISON. Care, Stone & Webster Eng. Corporation, Columbus, Ga.

DEATHS

BRIGGS, ROSWELL EMMONS. Elected Member, September 15th, 1869; died May 4th, 1911.

HADSALL, JOSEPH CANBY. Elected Associate Member, November 8th, 1909; died June 29th, 1911.

HAGUE, CHARLES ARTHUR. Elected Member, February 3d, 1892; died June 25th, 1911.

KENLY, EDWARD MARION. Elected Member, May 4th, 1904; died June 10th, 1911.

LEWERENZ, ALFRED COURTNEY. Elected Junior, March 5th, 1895; Associate Member, June 6th, 1900; Member, March 6th, 1906; died May 27th, 1911.

McGRATH, WALLACE. Elected Member, September 5th, 1883; died December 5th, 1909.

NORTH, EDWARD P. Elected Member, December 4th, 1867; died July 20th, 1911.

PATCH, HOMER AUSTIN. Elected Associate Member, January 8th, 1908; died April 4th, 1911.

SEARS, ALFRED FRANCIS. Elected Member, June 2d, 1869; died June 7th, 1911.

WOLKOWYSKI, ALEXANDER ILICH. Elected Junior, January 7th, 1908; died September 27th, 1910.

WOOD, CHARLES WIDNEY. Elected Member, October 7th, 1908; died April 3d, 1911.

Total Membership of the Society, August 1st, 1911, 6 129.

MONTHLY LIST OF RECENT ENGINEERING ARTICLES OF INTEREST

(May 6th to August 1st, 1911)

NOTE.—*This list is published for the purpose of placing before the members of the Society, the titles of current engineering articles, which can be referred to in any available engineering library, or can be procured by addressing the publication directly, the address and price being given wherever possible.*

LIST OF PUBLICATIONS

In the subjoined list of articles, references are given by the number prefixed to each journal in this list:

(1) *Journal*, Assoc. Eng. Soc., 31 Milk St., Boston, Mass., 30c.
(2) *Proceedings*, Engrs. Club of Phila., 1317 Spruce St., Philadelphia, Pa.
(3) *Journal*, Franklin Inst., Philadelphia, Pa., 50c.
(4) *Journal*, Western Soc. of Engrs., Monadnock Blk., Chicago, Ill.
(5) *Transactions*, Can. Soc. C. E., Montreal, Que., Canada.
(6) *School of Mines Quarterly*. Columbia Univ., New York City, 50c.
(8) *Stevens Institute Indicator*, Stevens Inst., Hoboken, N. J., 50c.
(9) *Engineering Magazine*, New York City, 25c.
(10) *Cassier's Magazine*, New York City, 25c.
(11) *Engineering* (London), W. H. Wiley, New York City, 25c.
(12) *The Engineer* (London), International News Co., New York City, 35c.
(13) *Engineering News*, New York City, 15c.
(14) *The Engineering Record*, New York City, 12c.
(15) *Railway Age Gazette*, New York City, 15c.
(16) *Engineering and Mining Journal*, New York City, 15c.
(17) *Electric Railway Journal*, New York City, 10c.
(18) *Railway and Engineering Review*, Chicago, Ill., 10c.
(19) *Scientific American Supplement*, New York City, 10c.
(20) *Iron Age*, New York City, 10c.
(21) *Railway Engineer*, London, England, 25c.
(22) *Iron and Coal Trades Review*, London, England, 25c.
(23) *Bulletin*, American Iron and Steel Assoc., Philadelphia, Pa.
(24) *American Gas Light Journal*, New York City, 10c.
(25) *American Engineer*, New York City, 20c.
(26) *Electrical Review*, London, England.
(27) *Electrical* World, New York City, 10c.
(28) *Journal*, New England Water-Works Assoc., Boston, Mass., $1.
(29) *Journal*, Royal Society of Arts, London, England, 15c.
(30) *Annales des Travaux Publics de Belgique*, Brussels, Belgium.
(31) *Annales* de l'Assoc. des Ing. Sortis des Ecoles Spéciales de Gand, Brussels, Belgium.
(32) *Mémoires et Compte Rendu des Travaux*, Soc. Ing. Civ. de France, Paris, France.
(33) *Le Génie Civil*, Paris, France.
(34) *Portefeuille Economiques des Machines*, Paris, France.
(35) *Nouvelles Annales de la Construction*, Paris, France.
(37) *Revue de Mécanique*, Paris, France.
(38) *Revue Générale des Chemins de Fer et des Tramways*, Paris, France.
(41) *Modern Machinery*, Chicago, Ill., 10c.
(42) *Proceedings*, Am. Inst. Elec. Engrs., New York City, 50c.
(43) *Annales des Ponts et Chaussées*, Paris, France.
(44) *Journal*, Military Service Institution, Governors Island, New York Harbor, 50c.
(45) *Mines and Minerals*, Scranton, Pa., 20c.
(46) *Scientific American*, New York City, 8c.
(47) *Mechanical Engineer*, Manchester, England.
(48) *Zeitschrift*, Verein Deutscher Ingenieure, Berlin, Germany.
(49) *Zeitschrift für Bauwesen*, Berlin, Germany.
(50) *Stahl und Eisen*, Düsseldorf, Germany.
(51) *Deutsche Bauzeitung*, Berlin, Germany.
(52) *Rigasche Industrie-Zeitung*, Riga, Russia.
(53) *Zeitschrift*, Oesterreichischer Ingenieur und Architekten Verein, Vienna, Austria.
(54) *Transactions*, Am. Soc. C. E., New York City, $4.
(55) *Transactions*, Am. Soc. M. E., New York City, $10.
(56) *Transactions*, Am. Inst. Min. Engrs., New York City, $5.

(57) *Colliery Guardian,* London, England.

(58) *Proceedings,* Engrs.' Soc. W. Pa., 803 Fulton Bldg., Pittsburg, Pa., 50c.

(59) *Transactions,* Mining Inst. of Scotland, London and Newcastle-upon-Tyne, England.

(60) *Municipal Engineering,* Indianapolis, Ind., 25c.

(61) *Proceedings,* Western Railway Club, 225 Dearborn St., Chicago, Ill., 25c.

(62) *Industrial World,* 59 Ninth St., Pittsburg, Pa.

(63) *Minutes of Proceedings,* Inst. C. E., London, England.

(64) *Power,* New York City, 20c.

(65) *Official Proceedings,* New York Railroad Club, Brooklyn, N. Y., 15c.

(66) *Journal of Gas Lighting,* London, England, 15c.

(67) *Cement and Engineering News,* Chicago, Ill., 25c.

(68) *Mining Journal,* London, England.

(70) *Engineering Review,* New York City, 10c.

(71) *Journal,* Iron and Steel Inst., London, England.

(71*a*) *Carnegie Scholarship Memoirs,* Iron and Steel Inst., London, England.

(73) *Electrician,* London, England, 18c.

(74) *Transactions,* Inst. of Min. and Metal., London, England.

(75) *Proceedings,* Inst. of Mech. Engrs., London, England.

(76) *Brick,* Chicago, Ill., 10c.

(77) *Journal,* Inst. Elec. Engrs., London, England.

(78) *Beton und Eisen,* Vienna, Austria.

(79) *Forscherarbeiten,* Vienna, Austria.

(80) *Tonindustrie Zeitung,* Berlin, Germany.

(81) *Zeitschrift für Architecktur und Ingenieurwesen,* Wiesbaden, Germany.

(83) *Progressive Age,* New York City, 15c.

(84) *Le Ciment,* Paris, France.

(85) *Proceedings,* Am. Ry. Eng. and M. of W. Assoc., Chicago, Ill.

(86) *Engineering-Contracting,* Chicago, Ill., 10c.

(87) *Roadmaster and Foreman,* Chicago, Ill., 10c.

(88) *Bulletin* of the International Ry. Congress Assoc., Brussels, Belgium.

(89) *Proceedings,* Am. Soc. for Testing Materials, Philadelphia, Pa.

(90) *Transactions,* Inst. of Naval Archts., London, England.

(91) *Transactions,* Soc. Naval Archts. and Marine Engrs., New York City.

(92) *Bulletin,* Soc. d'Encouragement pour l'Industrie Nationale, Paris, France.

(93) *Revue de Métallurgie,* Paris, France, 4 fr. 50.

(94) *The Boiler Maker,* New York City, 10c.

(95) *International Marine Engineering,* New York City, 20c.

(96) *Canadian Engineer,* Toronto, Ont., Canada, 15c.

(97) *Turbine,* Berlin, Germany, 1 Mark.

(98) *Journal,* Engrs. Soc. Pa., 219 Market St., Harrisburg, Pa., 30c.

(99) *Proceedings,* Am. Soc. of Municipal Improvements, New York City, $1.50.

(100) *Professional Memoirs,* Corps of Engrs., U. S. A., Washington, D. C., $1.

(101) *Metal Worker,* New York City, 10c.

(102) *Organ für die Fortschritte des Eisenbahnwesens,* Wiesbaden, Germany.

(103) *Mining and Scientific Press,* San Francisco, Cal., 10c.

(104) *The Surveyor and Municipal and County Engineer,* London, England, 6d.

(105) *Metallurgical and Chemical Engineering,* New York City, 25c.

(106) *Transactions,* Inst. of Mining Engrs., London, England, 6 shillings.

(107) *Schweizerische Bauzeitung,* Zurich, Switzerland.

(108) *Southern Machinery,* Atlanta, Ga., 10c.

LIST OF ARTICLES.

Bridges.

The Compressive Member. Horace E. Horton. (Paper read before the Civ. Engrs. Soc. of St. Paul.) (1) March.

The St. Louis Municipal Bridge.* Henry W. Hodge. (98) May.

Salisbury Viaduct, Western Maryland Railway.* (87) May.

The Suspended Span of the Beaver Bridge.* (14) May 6.

Concrete Highway Bridge over the French Broad River.* (14) May 6.

New Bridges Over False Creek at Vancouver.* (96) May 11.

Replacing Steel Viaducts on the Bessemer & Lake Erie.* (15) May 12.

Some Observations on Recent Bridge Construction in America. Henry S. Jacoby. (Abstract from *Cornell Civil Engineer.*) (13) May 18.

The Expansion Connections of Beaver Bridge.* (14) May 20.

A Reinforced Concrete Railroad Bridge Erected by Wrecking Cars.* (14) May 20.

Renewal of the Sandy Run Viaduct.* (14) May 20.

Concrete Slab Bridges, Pennsylvania Railroad.* (14) May 20.

An Unusual Method of Erecting a Bridge.* (12) June 2.

Construction of the Idaho & Washington Northern R. R.* (18) June 3.

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*Illustrated.

Bridges—(Continued).

The Erection of the Anchor Arm of the Beaver Bridge.* (14) June 3.
Reinforced Concrete Bridge of the Southern Ry. Co. at Asheville, N. C.* W. B. Crenshaw. (86) June 7.
Methods and Cost of Constructing a 145-Ft. Concrete Arch Bridge.* John McMichaels. (86) June 7.
Concrete Abutments for Highway Bridges.* H. E. Bilger. (Paper read before the Illinois Soc. of Engrs. and Surv.) (96) June 8; (67) July.
The Erection Adjustments of the Beaver Bridge.* (14) June 10.
A Suspended Flexible Centering for Masonry Arches as Used on the Chickahominy River Bridge, Virginia. Philip Aylett, Assoc. M. Am. Soc. C. E. (13) June 15.
A Protected Plate Girder Railroad Bridge.* (14) June 17.
The Erection Travelers used in Erecting the Beaver Bridge.* (14) June 24.
The Erection of the Cantilever Arm of the Beaver Bridge.* (14) July 1.
Impact Tests on Reinforced Concrete Trestle, C. M. & S. P. Ry. J. H. Prior. (18) July 1.
A Lining Device for Swing Bridges; Interstate Bridge of Duluth-Superior Bridge Co. at Duluth.* (13) July 13.
The Charles River Bridge of the Boston Elevated Railway.* (13) July 13.
Oregon-Washington Railroad & Navigation Company's Portland Bridge.* (15) July 14.
The Whitehaven Bridge Piers.* (14) July 15.
A Protected I-Beam Bridge over Railroad Tracks.* (14) July 15.
Contractors' Plant and Methods of Constructing the Galveston Causeway.* W. P. Parker. (86) July 26.
A Special Derrick-Car for Setting Girder Spans; San Pedro, Los Angeles & Salt Lake R. R.* (13) July 27.
The Preservation of Trestle Stringers and Caps by Means of Housing.* Hunter McDonald, M. Am. Soc. C. E. (Abstract of paper read before the Eng. Assoc. of the South.) (13) July 27; (15) June 16.
The Arroya del Chico Bridge.* (14) July 29.
Ponts Basculants et Roulants, Système Scherzer, des Chemins de Fer de l'Etat d'Oldenbourg (Allemagne).* (35) May.
Le Accès de la Gare Saint-Lazare, à Paris, Nouveau Pont d'Asnières, sur la Seine, Allongement du Pont sous la Rue Legendre.* Charles Rabut. (33) May 13.
Stössensee- und Havelbrücke im Zuge der Döberitzer Heerstrasse.* Karl Bernhard. (49) Pt. 4.
Die Brücken über die Dievenou und ihre Nebenarme.* H. Scholl. (78) July 20.
Die Knicksicherheit der Druckgurte offener Bogenbrücken.* Briske. (81) Pt. 3.
Gewölbe- und Rahmenberechnung nach der Elastizitätstheorie.* Heinrich Pilgrim. (81) Pt. 3.
Eisenbahnbrücken aus Eisenbeton.* Rud. Christiani. (Paper read before the Architekten- und Ingenieur-verein zu Hamburg.) (78) May 5.
Die Eisenbahnbrücke über den Neckar in Tübingen.* Charles Falio. (107) May 6.
Die im Zuge der Fogaras-Brassóer Eisenbahnlinie ausgeführten Eisenbeton-Hochbrücken. J. Kossalka. (102) Serial beginning May 15.
Neuere Klappbrücken mit beweglichen Drehachsen in Amerika.* Karl Bernhard. (51) Serial beginning May 20.
Bogenträger mit Zugbändern.* Humbert Ehrlich. (78) May 24.
Der Wettbewerb um den Bau der Quebec-Brücke; Vorschläge über die Aufstellung der Ueberbauten.* H. F. Borden. (48) July 15.

Electrical.

The Magnetic Properties of Iron and Its Alloys in Intense Fields.* Robert A. Hadfield and B. Hopkinson. (77) Apr.
Submarine Cables for Long-Distance Telephone Circuits.* W. A. J. O'Meara. (77) Apr.
A Graphical Treatment of the Skin Effect.* Alfred Hay. (77) Apr.
Static Sub-Station Design.* P. V. Hunter. (77) Apr.
Electric Driving of Continuous Rolling Mills. Gerald J. Hooghwinkel and Francis Thursfield. (Abstract of paper read before the Staffordshire Iron and Steel Inst.) (22) Apr. 28.
Merz-Price Protective Gear and Other Discriminate Apparatus for Alternating-Current Circuits.* K. Faye-Hansen and G. Harlow. (77) May.
Measurement of Relative Angular Displacement in Synchronous Machines.* W. W. Firth. (77) May.
The Benkö Primary Battery and its Applications.* W. R. Cooper. (77) May.
Modern Long-Distance Transmission of Electrical Energy. William T. Taylor. (77) May.
Extra-High-Pressure Transmission Lines.* R. Borlase Matthews and C. T. Wilkinson. (77) May.

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*Illustrated.

Electrical—(Continued).

The Van Horn-Endsley Spark Arrester. (From *Railway Gazette.*) (88) May.
An Example of Electric Motor Installation.* (108) May.
Choice of Rotor Diameter and Performance of Polyphase Induction Motors.* Theodore Hoock. (42) May.
Flywheel Load Equalizer.* W. N. Motter and L. L. Tatum. (42) May.
Multiplex Telephony and Telegraphy by Means of Electric Waves Guided by Wires.* George D. Squier. (42) May. (19) Serial beginning July 1.
Appraisal of the Seattle Telephone Companies by the Railroad Commission of Washington. Henry S. Gray, Assoc. M. Am. Soc. C. E. (86) May 3.
The Voltage between Commutator Segments.* Theodore Hoock. (Abstract from *Elektrotechnische Zeitschrift.*) (73) May 5.
The Construction of Standard Cells and a Constant Temperature Bath.* G. A. Hulett. (Abstract from *Physical Review.*) (73) May 5.
The Thomas Electromechanical Transmission for Motor Vehicles.* (73) May 5.
Test on 3 000-k.w. Turbo-Alternator. (47) May 5.
The Engineering of Indirect Illumination.* Jas. R. Cravath. (27) May 11.
Electrically Operated Capstan.* (96) May 11.
A Storage-Battery Truck for Handling Package Freight in Railway Freighthouses.* (13) May 11.
Electric Drive Potteries.* A. E. Rickards. (76) May 15.
Hydroelectric Energy for the Bedford Stone Industry.* (27) May 18.
Some Electrical Tests of Porcelain.* Ralph P. Clarkson. (27) May 18.
The Electric Lighting of Ceres Village, Cape Colony.* (26) May 19.
Transformer Oil. Alexander Duckham. (73) May 19.
On Shock Excitation with Quenching Tubes.* M. Wien. (Abstract from *Jahrbuch der Drahtlosen Telegraphie.*) (73) May 19.
Motor Installations at the Shops of the Chicago Railways Co.* (18) May 20.
Experience with Concrete Poles at Oklahoma City.* (27) May 25.
Some Notes on the Limitations and Advantages of Hydroelectric Power. Clarence P. Fowler. (27) May 25.
Electricity in New York City, Features and Statistics of the Generating Stations Operated by the Public Service Corporations.* (27) May 25.
New York Edison Company, Rebuilding of Waterside Station No. 1.* (27) May 25.
The Brooklyn Edison System, Generating Stations, Substations and Character of Load in City of Churches.* (27) May 25.
Retailing Niagara Power.* T. Croft and J. D. Mooney. (27) May 25.
Recent Increases in the Transmission Efficiency of Long-Distance Telephone Circuits.* Bancroft Gherardi, M. Am. Inst. E. E. (Abstract of paper read before the New York Telephone Soc.) (13) May 25.
United Electric Light & Power Company, Alternating-Current Distribution in Borough of Manhattan.* (27) May 25.
New Underground Trunk Lines of the American Telephone and Telegraph Co.* (13) May 25.
Underground Conduit Construction, Various Kinds of Subway Ducts Used in Manhattan and Methods of Installation.* Edwin R. Quinby. (27) May 25.
Induction Machines for Heavy Single Phase Motor Service. E. F. W. Alexanderson. (42) June.
Cost of Transformer Losses.* E. C. Stone and R. W. Atkinson. (42) June.
A New Magnetic Switch Control System.* C. Pirtle. (98) June.
The Electric Strength of Air.* John B. Whitehead. (42) June.
Solution to Problems in Sags and Spans.* Wm. Le Roy Robertson. (42) June.
Sag Calculations for Suspended Wires.* Percy H. Thomas. (42) June.
Wave Shape of Currents in an Individual Rotor Conductor of a Single Phase Induction Motor.* H. Weichsel. (42) June.
The Economical Design of Direct Current Electromagnets.* R. Wikander. (42) June.
Depreciation as Related to Electrical Properties.* Henry Floy. (42) June.
Telegraph Transmission.* Frank F. Fowle. (42) June.
Electrically Driven Reversing Rolling Mills. Wilfred Sykes. (42) June.
The Application of Current Transformers to Three-Phase Circuits.* J. R. Craighead. (42) June.
The High Efficiency Suspension Insulator.* A. O. Austin. (42) June.
Reinforced Concrete Poles.* R. D. Coombs and C. L. Slocum. (87) June.
A Study of the Telephone Situation in Seattle, Wash.; Report by C. H. Judson and F. B. Hall, Engineers. (13) June 1.
Northwest Station, Chicago, Commonwealth-Edison Company's Generating Plant, with 20 000-k.w. Units, now Building.* (27) June 1.
Combination Water-Works and Electric Plant at Winnetka, Ill.* (27) June 1.
Channel-Iron Supports for Electric Transmission Lines.* R. E. Neale. (Abstract from *La Technique Moderne.*) (26) June 2.
The Present State and Future Prospects of High Tension Cable Manufacture. Leon Lichtenstein. (Abstract from *Elektrotechnische Zeitschrift.*) (73) June 2.
Report of Committee on Overhead Line Construction, N. E. L. A. (17) June 3.

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Electrical—(Continued).

Toronto Hydro-Electric System, Rates for Electrical Energy. (96) June 8.
The Principle of the Static Balancer.* C. C. Hawkins. (73) Serial beginning June 9.
The Semi-Automatic Method of Handling Telephone Traffic.* E. E. Clement. (73) June 9.
Theory and Construction of Partial-Slot Windings for Polyphase Generators.* M. Seidner. (73) June 9.
The Sand-Rock Tunnels of the St. Paul Edison Company.* (27) June 15.
Electrical Generation at New Orleans.* (27) June 15.
Experiments in Impact Excitation. G. W. Nasmyth. (Abstract from *Physical Review.*) (73) Serial beginning June 16.
Electric-Power Distribution Plant in Yukon.* (11) June 16.
Cheapening Services for Electricity Supply with Special Reference to Three-Wire Continuous Current Work.* W. A. Vignoles. (73) June 23.
The Southwick Power Station of the Brighton Corporation. (73) June 23.
The Appraisal of the Madison Gas and Electric Co. (86) June 28.
The Aberdare Electricity and Destructor Works.* (26) June 30.
A Venezuelan Electric Light and Power Station, the Plant of the Valencia Electricity Co.* (26) June 30.
The Mechanical and Electric Characteristics of Transmission Lines.* Harold Pender and H. F. Thomson. (42) July.
Some Recent Tests of Oil Circuit Breakers.* E. B. Merriman. (42) July.
Development of the Modern Central Station.* Charles Proteus Steinmetz. (42) July.
The Commercial Loading of Telephone Circuits in the Bell System. Bancroft Gherardi. (42) July.
The Law of Corona and the Dielectric Strength of Air.* F. W. Peek, Jr. (42) July.
Automatic Motor Control for Direct Current Motors.* Arthur C. Eastwood. (42) July.
Elevator Control.* T. E. Barnum. (42) July.
Some Limitations of Rheostatic Control.* G. R. Radley and L. L. Tatum. (42) July.
Electric Line Oscillations.* G. Faccioli. (42) July.
The Use of Power-Limiting Reactances with Large Turbo-Alternators.* R. F. Schuchardt and E. O. Schweitzer. (42) July.
A Simple Analysis of the Induction Generator. J. H. Morecroft. (6) July.
Electric Furnaces.* Carl Hering. (3) July.
Electric Transients. Charles Proteus Steinmetz. (3) July.
On the Duration of Electrical Contact between Impacting Spheres.* A. E. Kennelly. (3) July.
The Illumination of Streets and Open Places. E. Darrow. (60) July.
The Applications of Electric Heating. J. A. Fleming. (29) Serial beginning July 7.
Electrical Power Distribution on the North-East Coast, the New Generating Station at Dunston-on-Tyne.* (26) July 7; (73) July 7; (22) July 7; (11) July 7; (12) July 7.
A British District Supply System.* (27) July 8.
Substitutes for Wood Trunking for Railway Signal Conduits. W. K. Sparrow. (Paper read before the Ry. Signal Assoc.) (18) July 8.
The Hydroelectric Development at Franklin, New Hampshire.* (14) July 8.
Recent Improvements in Single-Phase Motors.* W. A. Layman. (Abstract of paper read before the National Elec. Light Assoc.) (13) July 13.
Radio-Telegraphy.* G. Marconi. (Abstract of paper read before the Royal Inst.) (73) July 14.
Erie County Electric System.* (27) July 15.
Notes on Design, Construction and Operation of High Tension Electric Transmission Lines. C. D. Gray, M. Am. Inst. C. E. (Abstract of paper read before the Brooklyn Engrs. Club.) (13) July 20.
The Stability and Compensation of the Three-Phase Series Commutator Machine.* R. Rüdenberg. (Abstract from *Elektroteknik Zeitschrift.*) (73) July 21.
Practical Aspects of Printing Telegraphy. Donald Murray. (19) Serial beginning July 29.
Hydroelectric Transmission System for Quarry and Mill Work.* C. T. Maynard. (27) July 29.
An Approximate Method of Determining Power-Factor.* C. M. Jansky. (27) July 29.
Nouveau Mode d'Exploitation Télégraphique Système Multiplex "Mercadier-Magunna." H. Magunna. (32) Feb.
De la Concurrence en Matière de Distributions d'Energie Electrique. P. Weiss. (43) Mar.
Ein Beitrag zur Frage der Erwärmung der Elektrischen Maschinen.* Erwin Hinlein. (48) May 6.
Die Starkstromtechnik auf der Brüsseler Weltausstellung.* Wilhelm Kübler. (48) Serial beginning July 1.

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Marine.

Floating Dry Docks in the United States; Relative Value of Wood and Steel for their Construction.* William T. Donnelly. (91) Vol. 18.
An Analysis of Tests of Water-Tight Bulkheads with Practical Rules and Tables for their Construction.* William Hovgaard. (91) Vol. 18.
Coaling Warships from Colliers in Harbors.* Spencer Miller. (91) Vol. 18.
The Gyroscope for Marine Purposes.* Elmer A. Sperry. (91) Vol. 18.
Comparative Results in Steam and Coal Consumption with Turbines, Reciprocating Engines and a Combination of the Two on the Steam Yacht *Vanadis*. Clinton H. Crane. (91) Vol. 18.
Some Suggestions for Reducing the Loss by Fire on Vessels. Samuel D. McComb. (91) Vol. 18.
Two Marine Installations of Producer Gas.* Charles B. Page. (91) Vol. 18.
Lubrication of Marine Engines. J. Veitch Wilson. (Abstract of paper read before the Inst. of Marine Engrs.) (47) Apr. 28.
The Hydraulic Capstans at Belfast New Graving Dock.* (12) Apr. 28.
The Rolling of Ships.* George Idle, M. I. N. A. (Paper read before the Eng. and Scientific Assoc. of Ireland.) (12) Serial beginning Apr. 28.
Progress in Raising the United States Battleship *Maine*.* (14) May 20.
The White Star Liner *Titanic*.* (11) May 26.
A 180 Horse-Power Marine Oil Engine.* (12) May 26.
Design and Construction of Freight Steamships from the Cargo Transferring Standpoint.* H. McL. Harding. (95) June.
The White Star Steamship *Olympic*.* (95) June.
The Steamer *Sankaty*.* (95) June.
The Yacht *Progress* Fitted with 100-I.-H.-P. Gas-Engine and Producer.* (11) June 2.
The Coaling of Warships.* (11) June 23.
Progress on Dry Dock No. 4, Brooklyn Navy Yard.* (14) June 24.
200-Ton Electric Titan Crane at the Fairfield Works. (11) June 30.
Launch of the *Titanic*.* (95) July.
Toiler, a Diesel Oil-Engined Vessel of 2 700 Tons.* J. Rendell Wilson. (95) July.
Electrical Propulsion of Vessels.* (95) July.
Electrically Operated Auxiliary Apparatus.* M. W. Buchanan. (95) July.
Marine Electric Generating Plants, Distribution and Interior Communication Systems.* W. Y. Avery. (95) July.
Nouveaux Engins de Relevage pour Sous-Marine, Grue-Ponton de Pola (Autriche) et Dock Flottant (Allemagne).* A. Bidault des Chaumes. (33) June 24.
Les Paquebots *Olympic* et *Titanic* de la White Star Line. H. Brillié. (33) Serial beginning July 1.
Der neue Eimerbagger des Königlichen Wasserbauamts Emden.* Paulmann und Blaum. (49) Pt. 4.
Die Schwebefähre auf der Kaiserlichen Werft Kiel.* O. Franzius und W. Knopp. (48) Serial beginning May 13.
Die Dampfturbinen der neuen amerikanischen Torpedobootszerstörer.* (Abstract from *Journal*, American Society of Naval Engrs.) (97) Serial beginning May 20.
Die Entwicklung und die Zukunft des Massentransportes von Kohle und Erz über See.* Otto Lienau. (50) July 6.

Mechanical.

A Commercial Fuel-Briquette Plant. W. H. Blauvelt. (56) Vol. 41.
The Combustion of Coal.* (56) Vol. 41.
The Chemical Control of Slimes.* Harrison Everett Ashley. (56) Vol. 41.
Combustion in Cement-Burning. Byron E. Eldred. (56) Vol. 41.
The Condensation of Fumes and the Neutralization of Furnace-Gases. F. T. Havard. (56) Vol. 41.
Crushing Machines for Cyanide-Plants. Mark R. Lamb. (56) Vol. 41.
Power Plant Practice.* John A. Shaw. (5) Oct., 1910.
The Construction of a Westinghouse-Parsons Steam Turbine.* E. M. Webb. (5) Oct., 1910.
The Development of Road Locomotion in Recent Years.* L. A. Legros. (75) Nov., 1910.
The Production of Castings to Withstand High Pressures.* H. C. H. Carpenter and C. A. Edwards. (75) Dec., 1910.
The Constitution of Troosite and the Tempering of Steel.* Andrew McCance. (75) Dec., 1910.
Efficiency of Rope Drives.* W. Trinks. (58) Apr.
A Few Remarks on the Manufacture and Properties of Iron and Steel. H. P. Tiemann. (58) Apr.
Economic Generation in the Modern Central Power Station.* E. H. Tenney. (Paper read before the Engrs. Club of St. Louis.) (1) Apr.
The Protector Automatic Speed-Indicator and Recorder.* (11) Apr. 28.

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Mechanical—(Continued).

Official Test of 3 000-k.w. Turbo-Alternator at Bristol.* (26) Apr. 28; (73) Apr. 28.
Mechanical and Hydraulic Presses.*. Frank I. Ellis. (58) May.
Firebox Girder Stay Design.* F. A. Garrett. (94) May.
Diagonal Joints and Tube-Hole Rows.* (From *The Locomotive*.) (94) May.
Notes on the Design of Centrifugal Pumps.* N. W. Akimoff. (3) May.
Natural and Artificial Draft.* Henry G. Brinckerhoff. (3) May.
The Humphrey Pump.* A. P. Steckel. (98) May.
The Reconstruction of a Retort-House.* F. M. Paternoster. (Paper read before the Eastern Counties Gas Managers' Assoc.) (66) May 2.
Oxide Purification.* Ernest Scears. (Paper read before the Junior Gas Assoc.) (66) May 2.
Birmingham Coal Test Plant.* W. B. Davidson. (Paper read before the Junior Gas Assoc.) (66) May 2.
A Steam Turbine for Driving Direct-Current Generators and Other Low or Moderate Speed Machinery. (96) May 4.
Briquetting Pulverulent Iron Ore.* (22) May 5.
Electric Conversion of a Copper Rolling Mill.* (22) May 5.
Some Notes on the Speed and Power of Machine Tools.* Joseph Chilton. (Paper read before the Northeast Coast Inst. of Engrs. and Shipbuilders.) (47) May 5.
The Mechanical Equipment of the East Boston Deep Water Terminal.* (14) May 6.
Chamber Oven Process of Coal Gas Manufacture.* J. C. Markley. (Paper read before the Ill. Gas Assoc.) (24) May 8.
High Boiler Efficiency with Oil Fuel.* Frank T. Clarke. (64) May 9.
Teclu's Method of Ascertaining Heating and Illuminating Power of Coal Gas.* P. Phillips Bedson. (Paper read before the North of England Gas Mgrs. Assoc.) (66) May 9.
High and Low Pressure Distribution Schemes at Tynemouth.* (Paper read before the North of England Gas Mgrs.' Assoc.) (66) May 9.
The Manufacture and Properties of Hydrated Lime.* Richard K. Meade. (13) May 11.
A New Design of Blower for Increased Efficiency.* (13) May 11.
A Storage-Battery Truck for Handling Package Freight in Railway Freighthouses.* (13) May 11.
A Self-Closing Safety Crane Hook.* (13) May 11.
Large Gas Engines of the Two-Cycle Type.* Alan E. L. Chorlton, M. I. Mech. E. (Abstract of paper read before the Manchester Assoc. of Engrs.) (22) May 12.
Beet-Sugar Factories.* Hal Williams, M. I. Mech. E. (29) May 12.
A High Belt-Conveyor Bridge.* (14) May 13.
Aeroplane Propellers.* William McEntee. (46) May 13.
Automatic Stability of Aeroplanes.* Grover Cleveland Loening. (46) May 13.
Steam Consumption in Water Gas Plants of Moderate Size. L. B. Moorhouse. (Paper read before the Southwestern Elec. and Gas Assoc.) (83) May 15.
Application of Gas-Fired Steam Boilers. G. W. McKee. (Paper read before the Southern Gas Assoc.) (83) May 15.
Capacity of Ammonia Compressors.* F. E. Matthews. (64) May 16.
New Power Plant of Dennison Mfg. Co.* W. O. Rogers. (64) May 16.
Appraisal of Gas Properties in Chicago, and Investigation as to Reasonable Rates for Gas. Wm. J. Hagenah. (Abstract of paper read before Gas Sub-committee of the City Council of Chicago.) (86) May 17.
A 1 000-h.p. Oil Fuel Producer-Gas Power Plant.* (13) May 18.
The Stability of Aeroplanes.* A. P. Thurston. (11) May 19.
Heavy Main Work in South London.* (66) May 23.
Modernizing the Gas Street Works at Bolton.* (66) May 23.
Recommended Jobbing Shop Practice in Designing, Drafting and Cutting Spur and Bevel Gears.* G. A. Bisset. (13) May 25; (47) June 16.
Coal Briquetting Plant.* Charles T. Malcolmson. (15) May 26.
Aeroplane Under-carriages.* (From *Flight*.) (19) May 27.
Equipment of Air Furnaces Using Fuel Oil. W. N. Best. (Paper read before the Am. Foundrymen's Assoc. and Am. Brass Founders' Assoc.) (62) May 29.
Comparisons of Upright and Inverted Low-Pressure Burners.* M. Grebel. (Paper read before the Soc. Technique du Gaz.) (66) May 30.
Tar Condensation in Paris Gas-Works. Henri Laurain. (Paper read before the Soc. Technique du Gaz.) (66) May 30.
Blair's Zinc-Lead Pigment Plant. J. I. Blair. (45) June.
The Machinery of the Steel Industry.* Robert L. Streeter. (9) June.
Dynamics of the Flying Machine.* James S. Stephens. (4) June.
Economics in the Production of Power.* Edward T. Child. (98) June.
Manufacture of Cement Drain Tile.* Charles E. Sims. (Paper read before Northwestern Cement Products Assoc.) (67) June.
The Nelson Valve Company's New Works.* (20) June 1.
A New Design of Railway Coaling Station.* (13) June 1.

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Mechanical—(Continued).

Briquetting Metal Borings.* Richard Moldenke. (Abstract of paper read before the Amer. Foundrymen's Assoc.) (20) June 1.
Hot-Water Receivers.* Charles T. Baird. (27) June 1.
Report on the Prime Motive Powers. I. E. Moultrop. (Abstract of paper read before the Nat. Elec. Light Assoc.) (17) June 3.
A Mexican Town and a Modern Gas Works. W. S. Aldrich. (24) June 5.
Flue-Gas Analysis. Joseph W. Hays. (Abstract of paper read before the Ohio Soc. of Mech. and Steam Engrs.) (62) June 5; (64) June 6.
Automatic Temperature Controlling Instrument.* E. F. Lake. (20) June 8.
A Cliffside Steam-Turbine Plant, Northern Heating & Electric Company's Station in St. Paul, and Its Sand-Rock Distributing Tunnels.* (27) June 8.
The Stone Crushing Plant of the Acton Rock Co., Los Angeles, Cal.* (13) June 8.
The Traveling Crane in Terminal Freight Handling.* H. McL. Harding. (14) June 10.
Cupola Practice: American. R. H. Palmer. (Paper read before the Am. Foundrymen's Assoc.) (62) June 12.
Cupola Practice: British. P. Munnoch. (Paper read before the Am. Foundrymen's Assoc.) (62) June 12.
A New Illinois Structural Mill.* (20) June 15.
Steel Derricks and Drilling Rigs.* R. B. Woodworth. (Paper read before the Natural Gas Assoc. of America.) (83) June 15.
Machinery Used for Pumping Natural Gas. E. S. McClelland. (Paper read before the Natural Gas Assoc. of America.) (83) June 15.
The Tunnel Kiln.* A. V. Bleininger. (76) June 15.
The Kiln Problem. Ellis Lovejoy. (76) June 15.
Oil Burning Statistics, Report showing Comparative Cost of Burning with Different Fuels and Analysis of Clay Used. (76) June 15.
Operation of Natural Gas Compressing Stations. James S. Posgate. (Paper read before the Natural Gas Assoc. of America.) (83) June 15.
Pipe-Molding Machine and Continuous Pipe Foundry at Coshocton, Ohio.* (13) June 15.
The Design of Cams for High-Speed Motors.* Robert F. McKay. (12) June 16.
Carbonizing Systems, a Review and a Selection.* P. C. Holmes Hunt. (Paper read before the Inst. of Gas Engrs.) (66) June 20.
The Use of High-Pressure Gas for Industrial Purposes.* E. W. Smith. (Paper read before the Inst. of Gas Engrs.) (66) June 20.
Notes on the Corrosion of Service-Pipes (Gas). James M'Leod. (Paper read before the Inst. of Gas Engrs.) (66) June 20.
The Dessau Vertical Retorts at Sunderland.* Charles Dru Drury. (Paper read before the Inst. of Gas Engrs.) (66) June 20.
The Scientific Carbonization of Coal. J. G. Newbigging. (Paper read before the Inst. of Gas Engrs.) (66) June 20.
Auxiliary Oil Firing in Steam Boiler Plants.* H. A. Wagner, M. Am. Inst. E. E. (13) June 22; (47) July 14.
The Use of Motor Trucks on Construction Work and for Haulage Purposes.* (13) June 22.
Gary 60-Inch Universal Plate Mill.* (20) June 22.
Notes on Fuel Economy. C. E. C. Shawfield. (73) June 23.
Gas Cavities, Shot and Chilled Iron in Iron Castings. Thomas D. West. (Paper read before the Amer. Foundrymen's Assoc.) (11) June 23; (47) June 16.
An Air Propeller Testing Apparatus, Professor Prandtl's System.* (19) June 24.
The Gyro-Compass.* (11) June 23.
International Harvester Tractor Works.* (20) June 29.
The Tilling Petrol-Electric 'Bus.* (26) June 23.
The Appraisal of the Madison Gas and Electric Co. (86) June 28.
The Aeronautical Motor.* E. W. Roberts. (Paper read before the National Gas and Gasoline Engine Trades Assoc.) (96) June 29.
Titanium for Malleable Iron. C. H. Gale. (Paper read before the Amer. Foundrymen's Assoc.) (47) June 30.
The New Stone Crushing Plant of the Chicago Union Lime Works.* (67) July.
Sand-Lime Products.* E. Leduc and Ch. de la Roche. (67) Serial beginning July.
Specifications for Cast Iron Pulleys.* A. W. Wackerman. (108) July.
High-Speed Tools and Machines to Fit Them.* H. I. Brackenbury. (75) July.
Steam Auxiliary to Hydroelectric Installation.* J. W. Fraser. (27) July 1.
Lubricating Oil. Frederick W. Mann. (Paper read before the Venango Engrs. Club.) (98) July.
Development of High-Speed Drilling-Machines. L. P. Alford. (75) July.
Tooth Gearing.* J. D. Steven. (75) July.
Interchangeable Involute Gearing.* Wilfred Lewis. (75) July.
Rapid Production in Machine Work.* John Calder. (75) July.
Data on Manufacturing Methods with Machine Tools.* Luther D. Burlingame. (75) July.

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Mechanical—(Continued).

The Cincinnati Bickford Shops.* (20) July 6.

A Comparison of Costs of Power Supply from Low Head Hydraulic Plants and Steam Plants. Arthur H. Ford. (Abstract of paper read before the Iowa Soc. of Engrs.) (96) July 6; (86) June 14.

Strength of Rawhide Drives. W. H. Diefendorf. (From *American Machinist.*) (47) July 7.

Gas Engines and Producer Plants for Power Stations.* R. M. Carr. (Abstract of paper read before the Mun. Elec. Assoc.) (47) July 7; (73) June 30.

Standards of Safety in Relation to Machinery.* David S. Beyer. (20) Serial beginning July 13.

An Oil Gas Producer.* (20) July 13.

Producer Gas. W. A. Bone. (Paper read before the West of Scotland Iron and Steel Inst.) (47) July 14.

Internal-Combustion Engines Working on the Diesel Principle. H. L. Howard. (Abstract of paper read before the Inc. Mun. Elec. Assoc.) (47) July 14; (73) June 30.

The Works of Messrs. Brown, Boveri and Co., Baden.* (11) July 14.

The "Stock" Oil-Fired Converter at Darlington Forge.* (11) July 14; (12) July 14.

An Interesting Isolated Power Plant.* Warren O. Rogers. (64) July 18.

Steel Castings from Electric Furnace, one Phase of the Roechling-Rodenhauser Induction Furnace.* C. H. Von Baur. (Abstract of paper read before the Amer. Foundrymen's Assoc.) (20) July 20.

Pouring and Melting Points of some High-Grade Bronzes. C. P. Karr. (Paper read before the Amer. Brass Founders' Assoc.) (47) July 21.

The Works of Messrs. Sulzer Brothers, Winterthur.* (12) July 21.

The Works of Messrs. Escher Wyss and Co., Zurich.* (12) July 21.

The Swiss Locomotive and Engineering Works, Winterthur.* (12) July 21.

The De Laval Steam Turbine for Driving Low or Moderate Speed Machinery.* (73) July 21.

Steam Turbo-Generating Station.* (27) July 22.

A Wire Ropeway for German East Africa, Transporting Lumber in a Jungle.* Frederick C. Coleman. (19) July 29.

Efficient Drying of Cement Rock, Records of Actual Tests of Equipment at Plants of Pennsylvania Cement Co., Bath, Pa.* (62) July 31.

The Speed and Power of Machine Tools.* (25) Aug.

Problems and Progress in Aviation.* William D. Ennis. (9) Aug.

Test with Oil Fuel. (From *Journal*, Amer. Soc. Naval Engrs.) (64) Aug. 1.

Richmond's New Municipal Plant.* (64) Aug. 1.

Progrès de l'Aérodynamique, Expériences et Mesures sur l'Aéroplane en Plein Vol.* J. LeGrand. (32) Mar.

Note de M. G. Eiffel sur son Ouvrage la Resistance de l'Air et l'Aviation.* (32) Mar.

Les Moteurs à Combustion Interne et en Particulier le Moteur Diesel.* P. Du Bousquet. (32) Apr.

Etudes Expérimentales sur les Hélices Propulsives Aériennes. Legrand. (92) Apr.

Etude de la Combustion dans les Foyers Mécaniques et en Particulier dans le Foyer Savary.* J. Izart. (32) May.

Les Fours à Gaz à Chambres Horizontales de l'Usine d'Elbeuf (Seine-Inférieure).* Bernard Krafft. (33) May 20.

Note Relative au Calcul des Disques à Grande Vitesse de Rotation avec Application aux Volants à Voile Plein.* E. Rousseau et E. Biévez. (30) June.

Déchargement et Transport des Charbons du Port à l'Usine à Gaz de Nice.* G. Birlé. (33) June 3.

Les Mesures Aérodynamiques sur les Aéroplanes de Dimensions Normales.* M. Bousquet. (33) June 10.

Sur la Transformation d'un Moteur à Vapeur Actionnant un Laminoir à Toles Fines.* Charles Reignier. (37) June.

Accouplements pour Arbes de Transmission.* Pierre Blanc. (37) June 30.

Uber den Einfluss des Wasserdampfes und des Strahlungsverlustes der Vergasungszone auf die Vergasung fester Brennstoffe im Gaserzeuger.* Jul. Voigt. (52) Apr. 15.

Die Spezifische Wärme c_p des überhitzten Wasserdampfes für Drücke von 2 bis 8 kg/qcm und Temperaturen von 350 bis 550° C.* Oscar Knoblauch und Hilde Mollier. (48) Apr. 29.

Ein Versuch zur Erklärung der Rolle der Schlacke in unseren Hüttenprozessen.* Carl Dichmann. (50) Serial beginning May 11.

Schleifscheiben, ihre Herstellung und Verwendung.* W. Herminghausen. (50) May 25.

Wirkungsweise und Berechnung der Windkessel von Kolbenpumpen.* Anton Gramberg. (48) Serial beginning May 27.

Ueber Führungen an neueren Draht- und Feinstrassen.* Fr. Münker. (50) June 1.

Versuche an einer Generatorgasanlage.* Kurt Neumann. (48) June 3.

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Mechanical—(Continued).

Neuere Bestrebungen in der Verwendung der Gase in Eisenhütten und Kokereien. Fritz W. Lürmann. (50) June 8.

Die Wärmeausnutzung der heutigen Kolbendampfmaschine.* K. Heilmann. (48) Serial beginning June 10.

Beiträge zur Berechnung der Zentripital (Francis) Turbinen.* Camerer. (48) Serial beginning June 10.

Die Torfgewinnungsmachine Bauart Strenge.* Paulmann und Blaum. (48) June 17.

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Method of Estimating the Probable Volume of Railway Traffic.* George Rathjens. (Paper read before the Civ. Engrs. Soc. of St. Paul.) (1) Mar.
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China's Most Modern Railway.* Lewis R. Freeman. (15) June 2.
Setting Outside Admission Valves with Walschaert Gear.* (From Record No. 70 Baldwin Locomotive Works.) (15) June 2.
Repair Shops and Locomotive Terminal; Kansas City, Mexico & Orient.* (15) June 2; (18) June 24; (87) July.
Lubricating Locomotive Valves and Cylinders with Graphite.* (15) June 2.
Boring, Turning and Mounting Car Wheels and Axles.* W. H. Markland. (15) June 2.
Some French Locomotive Performances.* J. T. Burton-Alexander. (12) Serial beginning June 2.
The Great Zig-zag on the Great Western Railway, New South Wales.* (11) June 2.
Central Power Plants and Electricity Supply for Trunk Line Railroads. Fred Darlington. (Abstract of paper read before the National Elec. Light Assoc.) (17) June 3.
Parma Single-Phase Railway.* (17) June 3.
Running Triple Valves Without Lubrication. Lincoln Leonard. (Abstract of paper read before the Air Brake Assoc.) (18) June 3.
Friction of New and Worn Brake Shoes on New and Worn Cast Wheels.* A. S. Williamson. (Abstract of paper read before the Air Brake Assoc.) (18) June 3.
Maintenance of Equipment Costs.* C. J. Morrison. (15) June 9.
Controlling Modern Passenger Trains.* Walter V. Turner. (Abstract of paper read before the Air Brake Assoc.) (15) June 9; (96) June 22; (13) July 6; (18) July 15.
Car Equipment Inspection and Maintenance on the Long Island Railroad.* (17) June 10.
New 82-Ton Electric Locomotive of the Northern Electric Railway.* J. Paulding Edwards. (17) June 10.
New Roundhouse of the Intercolonial Ry. of Canada at Campbellton, N. B.* (18) June 10.
The New Chicago & Northwestern Ry. Passenger Terminal in Chicago.* (18) June 10; (15) June 9; (87) June.
Improvements on the Montclair Branch, Lackawanna Railroad.* (14) June 10.
Methods of Computing the Dimensions of Railway Crossings.* (86) June 14.
Cost of Railroad Signal Protection. James B. Latimer. (86) June 14.
The Importance of Scientific Investigation in Railroad Contracting.* John W. King. (Paper read before the Am. Soc. of Eng. Contractors.) (96) June 15.
Some Further Notes on Train Resistance. C. F. Dendy Marshall. (12) June 16.
Rainy Lake Revison of Line of the Canadian Northern.* (15) June 16.
Enlargement of the Covington Tunnel.* (15) June 16.
Mikado and Pacific Type Locomotives; Baltimore & Ohio.* (15) June 16; (18) June 10.
Kinds of Wood Best Adapted for Cross Ties. F. J. Angier. (Paper read before the Burlington Assoc. of Operating Officers.) (15) June 16; (96) July 27.
Forty-Foot Refrigerator Car.* (15) June 16.
Waldron's Automatic Stop.* J. M. Waldron. (Paper read before the Ry. Signal Assoc.) (15) June 16.
Mallet Articulated Locomotives for the Duluth, Missabe & Northern Ry.* (18) June 17.
Apparatus for Charging Storage Batteries (Signals).* H. K. Ferguson, R. E. Russell and E. E. Kimball. (Paper read before the Ry. Signal Assoc.) (18) June 17.
Express Refrigerator Cars for the Chicago, Milwaukee & Puget Sound Ry.* (18) June 17.
Locomotive Using the "Straight Flow" System of Steam Distribution.* (18) June 17.
New Steel Motor Cars of the Long Island Railroad.* (17) June 17.
Efficiency and Economy in Hot Water Boiler Washing.* (18) June 17.
Pennsylvania Terminal Service Plant.* A. D. Blake. (64) June 20.
Electric Trucks for Handling Baggage and Freight. (13) June 22.

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Table for Use in Determining Earth Pressure on Retaining Walls.* W. E. Weston. (13) June 22.
4-6-0 Type Passenger Compound Locomotive; Portuguese Railway.* (11) June 23.
The "A B C" Central-Buffer Coupler.* (11) June 23.
New Rolling Stock, Swedish State Railways.* (12) June 23.
M., K. & T. Freight House at St. Louis.* (15) June 23.
57½-Ton Steel Hopper Coal Car; Norfolk & Western.* (15) June 23.
Prentice's Wireless Train Control.* (15) June 23.
Automatic Block Signals on the Illinois Traction System.* John Leisenring. (17) June 24; (14) June 17.
Operating Practices of the Hudson Companies.* (17) June 24.
The Paulding and Mace Avenue Subway, New York.* (14) June 24.
The Madeira-Mamoré Railway.* P. H. Ashmead. (15) June 30.
New Signaling at Washington; P. B. & W.* (15) June 30.
Heat Balances in Locomotive Boilers. Lawford H. Fry. (11) June 30.
Balanced Compound Locomotives and Their Working on the State Railways of Prussia.* Charles R. King, M. I. C. E. (21) July.
The M. D. M. System of Power Signalling.* (21) July.
Electrification of Suburban Railways.* F. W. Carter. (75) July.
The Cost of Electrically-Propelled Suburban Trains. H. M. Hobart. (75) July.
The Electrification of Railways: An Imperative Need for the Selection of a System for Universal Use.* George Westinghouse. (75) July.
Economics of Tonnage Rating.* J. G. Van Zandt. (87) July.
Signaling on the Atlantic Coast Line.* (87) July.
Economics of Railway Electrification.* Wm. Bancroft Potter. (75) July.
Electrification of Trunk Lines. L. R. Pomeroy. (75) July.
English Running-Shed Practice.* Cecil W. Paget. (75) July.
Handling Locomotives at Terminals. Frederic M. Whyte. (75) July.
Engine-House Practice, or the Handling of Locomotives at Terminals to Secure Continuous Operation.* F. H. Clark. (75) July.
American Locomotive Terminals.* William Forsyth. (75) July.
Handling Engines.* H. H. Vaughan. (75) July.
Locomotive Shops at Cape Charles, Va.* (25) July.
Pacific Type Locomotive Arranged for Burning Lignite.* (25) July.
A Tabular Comparison of Notable Examples of Recent Locomotives Arranged with Respect to Classes and Weights. (25) July.
Locomotive Performance under Different Degrees of Superheated Steam. C. H. Benjamin and Louis E. Endsley. (Paper read before the Amer. Ry. Master Mechanics' Assoc.) (25) July; (18) July 1.
Repair Equipment for Engine Houses. (Report to Amer. Ry. Master Mechanics' Assoc.) (25) July.
Contour of Tires.* (Report, Amer. Ry. Master Mechanics' Assoc.) (25) July.
Revision of Code of Tests.* (Report, Amer. Ry. Master Mechanics' Assoc.) (25) July.
Train Brake and Signal Equipment.* (Report, Amer. Ry. Master Mechanics' Assoc.) (25) July.
Mallet Superheater Locomotives for the Delaware & Hudson Co.* (18) July 1.
Passenger Station Shelters at Steubenville, Ohio.* (14) July 1.
Electrification of the Hoosac Tunnel.* (17) July 1; (64) July 4; (13) June 8.
Handling Freight by Telpherage in a St. Louis Railway Terminal.* (14) July 1.
Structural Features of the Missouri, Kansas & Texas Terminal Freight House.* (14) July 1.
Creosoting Plant of the Pennsylvania R. R. at Philadelphia, Pa.* Grant B. Shipley. (13) July 6.
Setting Inside Admission Piston Valves with Walschaert Gear.* (15) July 7.
New Shops of the New York, Philadelphia & Norfolk.* (15) July 7.
Passenger Locomotive for the Central Argentine Railway.* (11) July 7.
Superheating on the Chicago and North-Western Railroad.* (12) July 7.
Flange Lubrication.* (Abstract of report to Amer. Ry. Master Mech. Assoc.) (18) July 8; (25) Aug.
Mallet Articulated Freight Locomotives for the Southern Pacific Co.* (18) July 8.
Latest Type of Interurban Car for McKinley System.* (17) July 8.
Construction of Bloomfield Grade-Crossing Improvements.* (14) July 8.
Values of Curvature, Distance, Rise and Fall. F. Lavis, M. Am. Soc. C. E. (14) July 8.
Tests of Resistance of Freight Car Trucks when out of Square. (13) July 13.
A Suspended Railway to the Aiguille du Midi.* Alfred Gradenwitz. (26) July 14.
The Hanna Locomotive Stoker.* (15) July 14.
Venice Power Station of Illinois Traction System.* (17) July 15.
Gas-Electric Motor Cars. W. B. Potter. (96) July 20.
The Effect of Grades on Operating Costs.* C. J. Morrison. (15) July 21.

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Electric Switching Locomotive; New York, New Haven & Hartford.* (15) July 21.
The Use of Rail Anchors.* (15) July 21.
Second Track Construction on the Pennsylvania between Indianapolis and Richmond.* (15) July 21.
Derrick Cars in Maintenance Work.* (15) July 21.
Combined Carhouse and Shop, Bridgeport, Conn.* (17) July 22.
A Trackless Trolley System in England. (14) July 22.
Gasoline-Electric Traction in Europe.* Francis E. Drake. (27) July 22.
The Grand Trunk Transcontinental Canadian Railway, a New 3 590-Mile Road with Light Grades and Easy Curves.* (19) July 22.
Frog and Switch Shops of the C., M. & St. P. Ry., at Tomah, Wis.* (18) July 22.
Pacific Type Locomotives for the Minneapolis, St. Paul & Sault Ste. Marie Ry.* (18) July 22; (25) Aug.
The Testing of Locomotive Fuel.* F. O. Bunnell. (Abstract of paper read before the Inter. Ry. Fuel Assoc.) (18) July 22.
A Study of the Ventilation of Sleeping Cars. Thomas R. Crowder. (Abstract of paper read before the Amer. Public Health Assoc.) (96) July 27.
Single-Phase Locomotive Equipment for the Loetschberg Line in Switzerland.* M. P. Misslin. (27) July 29; (17) July 29.
A Practical Demonstration in Fuel Economy.* (15) July 28.
The Determination of Rock Temperature in Long and Deeply Overlaid Tunnels.* E. Lauchli. (14) July 29.
Electric Freight Trucks used by the Erie R. R. at Jersey City, N. J.* (18) July 29.
The Bay Ridge Improvement of the Long Island Railroad.* (14) July 29.
Locomotive Terminal at New Durham, N. J.* (25) Aug.
Tests of Brake Shoes.* (Report of Comm. Master Car Builders' Assoc.) (25) Aug.
Report of Comm. on Best Construction of Locomotive Frames.* (Master Mechanics' Assoc.) (25) Aug.
Solutions Nomographiques de Questions Relatives aux Chemins de Fer.* L. Potin. (43) May.
Calcul des Longerons Armés pour Véhicules de Chemins de Fer.* A. Nachtergal. (34) May.
Quadruplement de Voies et Construction de Lignes Nouvelles dans la Banlieue Desservie par la Compagnie du Nord.* L. Finat. (38) May.
L'Electrification des Chemins de Fer. de Valbreuze. (92) May.
Nouvelle Méthode d'Essai des Rails.* Ch. Fremont. (33) May 6.
L'Eclairage des Trains, Etude du Remplacement de l'Eclairage au Gaz par l'Eclairage Electrique.* (33) Serial beginning May 13.
Automotrices des Chemins de Fer du Sud de la France à Courant Monophasé (6 000 volts).* (33) May 27.
Traction Electrique par Courant Alternatif Monophasé Transformé sur la Locomotive en Courant Continu Essais Effectués sur la Ligne de Cannes à Grasse.* Auvert. (38) June.
Frein à Cric et Barillet de M. Mestre.* E. Sauvage. (92) June.
De l'Influence des Wagons de Grande Capacité sur les Crises de Transport. A. Henry. (92) June.
Nouvelles Locomotives Compound Articulées Système Mallet.* L. Pierre-Guédon. (33) June 10.
La Répétition des Signaux sur les Locomotives, ses Avantages et ses Inconvénients.* (33) Serial beginning June 24.
Note sur le Chemin de Fer Electrique de la Bernina.* J. Lhériaud. (38) July.
Note sur le Nouveau Matériel à Voyageurs de la Compagnie des Chemins de Fer Portugais et les Transformations Apportées à l'Ancien Matériel.* Henri Lavialle d'Anglards. (38) July.
Nouvelle Méthode de Freinage Continu des Longs Trains de Marchandises.* H. Sabouret. (33) July 15.
Neuerungen im Baue von Weichen.* Schmitt. (102) Apr. 15.
Einwellen-Wechselstrom-Bahnen, Ausführungen der Siemens-Schuckert-Werke.* (102) Apr. 15.
Einstellbares Hinter-Drehgestell für lange Lokomotiven.* R. Grimshaw. (102) Apr. 15.
Die elektrische Bahn Martigny-Orsières.* G. Huldschiner. (107) Serial beginning Apr. 22.
Die Schnellzuglokomotiven der k. k. österreichischen Staatsbahnen.* Richard Baecker. (53) Apr. 28.
Kurvenbewegliche Transportlokomotive nach Klien-Lindner.* V. Litz. (48) Apr. 29.
Neuere Lokomotiven der Lokomotivfabrik J. A. Maffei.* K. Vogl. (102) May 1.
Entgleisungsursachen und die Deutung der Aufschreibungen des Gleismessers von Dorpmüller. H. Dorpmüller. (102) May 1.

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Ein Beitrag zur Lehre von den Gegengewichten der Lokomotive.* J. Jahn. (102) Serial beginning May 1.

Die Einführung der linksufrigen Zürichseebahn in den Hauptbahnhof Zürich der S. B. B.* (107) Serial beginning May 6.

Heissdampf-Lokomotiven der Thunerseebahn Serie Ec 4/6.* (107) May 13.

Elektrische Zugförderung auf preussischen Staatsbahnen. (51) May 17.

Walzfiguren in einem Schienenprofil.* R. Loebe. (50) May 18.

Versuchsfahrten mit 2C1-Vierzylinderverbund-Heissdampflokomotiven der württembergischen Staatseisenbahnen.* Dauner. (48) May 27.

Brig-Furka-Disentis-Bahn.* (107) June 10.

Die Anwendung des Eisenbetons im Eisenbahnbau.* K. W. Schaechterle. (51) Serial beginning June 10.

Die elektrische Zugförderung auf der Strecke Blankenese-Ohlsdorf. H. v. Glinski. (102) June 15.

Sicherheitsvorschriften für die Einrichtung elektrischer Beleuchtung in Eisenbahnwagen. (102) June 15.

Zur Ermittelung der Anzahl der Gleisunterhaltungsarbeiter und der Gleisunterhaltungskosten. Lotz. (102) Serial beginning June 15.

Das deutsche Eisenbahnwesen in der Internationalen Industrie- und Gewerbeausstellung, Turin 1911.* R. Anger. (48) Serial beginning June 17.

Vom Bau der Weissensteinbahn.* Werner Luder. (107) Serial beginning July 1.

Vierzylinder-Verbund-Heissdampflokomotive Serie A 3/5 der S. B. B.* (107) July 1.

Linienführung und Unterbau industrieller Bahnen.* A. Bielschowsky. (80) July 6.

Elektrische Industriebahnen.* P. Büttner. (80) July 11.

Railroads, Street.

Rail-less Electric Traction in Bremen.* (From *Physical Review.*) (73) Apr. 28. Apr. 28.

Electric Railway Block Signaling.* (87) May.

The New North-South Subway in Paris.* (14) May 13; (12) June 23.

Lengthening the Station Platforms of the New York Subway.* Walter G. Federlein, Assoc. M. Am. Soc. C. E. (14) May 13.

The 191st Street Subway Station, New York City.* (14) May 20.

New Express Cars of the Old Colony Street Railway.* (17) May 20.

Method of Constructing a Section of Passenger Subway on Cylinder Piers, Paris, France.* (86) May 24.

System of the Havana Electric Railway Company.* F. W. Hild. (17) Serial beginning May 27.

Results of 1 200-Volt Direct-Current Operation on the Washington, Baltimore & Annapolis Electric Railway.* (17) May 27.

A Remodeled Street Railway Plant.* Warren O. Rogers. (64) May 30.

Manganese Steel in Street Railway Special Work.* (86) May 31.

Testing and Manufacture of Reinforced Concrete Trolley Poles.* (14) June 24.

Standard Car of the New South Wales Government Tramways.* (17) July 1.

Steps in the Solution of the Problem of Adequately Controlling Electrically Propelled Vehicles. W. V. Turner. (Abstract of paper read before the St. Ry. Assoc. of the State of New York.) (17) July 1.

The Edison-Beach Storage Battery Car. R. H. Beach. (Abstract of paper read before the St. Ry. Assoc. of the State of New York.) (96) July 20.

A Few Reasons why Electric Traction in England Remains Stationary.* Gerald H. J. Hooghwinkel. (Abstract of paper read before the Tramways and Light Rys. Assoc.) (73) July 21.

Novel Methods in the Brooklyn Fourth Ave. Subway Construction, New York City: Section 11-A-3.* S. P. Brown, M. Am. Soc. C. E. (13) July 27.

Le Chemin de Fer Métropolitain de Paris, Ligne No. 4, de la Porte de Clignancourt à la Porte d'Orléans.* J. Hervieu. (35) Serial beginning June.

Les Ascenseurs et Escaliers Mécaniques du Métropolitain de Paris.* P. Calfas. (33) June 17.

Die künftigen Wiener elektrischen Untergrund-Schnellbahnen. O. Blum. (102) Serial beginning July 1.

Sanitation.

The Water-Works and Sewerage of Monterrey, N. L., Mexico.* George Robert Graham Conway, M. Am. Soc. C. E. (54) Vol. 72.

The Relation of Flies to the Transmission of Infectious Diseases.* Herbert D. Pease. (28) Mar.

The Use of the Salinometer in Studies of Sewage Disposal by Dilution.* Kenneth Allen, M. Am. Soc. C. E. (Paper read before the Boston Soc. of Civ. Engrs.) (1) Apr.

Pumping Plant for Sewerage and Waterworks.* Alfred J. Price. (Paper read before the Inst. of Mun. and County Engrs.) (104) Serial beginning Apr. 28.

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Heating Flueless Rooms.* J. H. Brearley. (Paper read before the Gas Mgrs. Assoc.) (66) May 2.

Some of the Public Works of Croydon.* Geo. F. Carter. (Paper read before the Inst. of Mun. and County Engrs.) (104) May 5.

Bacterial Purification of Ammonia-Recovery Liquor. Gilbert J. Fowler, E. Ardern and W. T. Lockett. (Abstract of paper read before the Soc. of Chemical Industry.) (66) May 9.

A 37-Mile Ditch System for Draining 77 000 Acres of Bottom Lands in Carroll County, Missouri, with Estimates of Cost.* (86) May 10.

Cost of Pipe Sewers and Appurtenances in Water Bearing Sand, Gary, Indiana.* (86) May 10.

Factory Sanitation and Efficiency. C.-E. A. Winslow. (Paper read before the Mass. Inst. of Tech.) (14) May 13.

Sedimentation in an Experimental Imhoff Tank.* (14) May 13.

A Florida Drainage Project. (14) May 13.

Ventilation Equipment, Hotel Sherman.* (101) May 13.

Revision of Downtown Chicago's Sewerage System. (86) May 17.

Sanitary Engineering Conditions in Milwaukee. (14) May 20.

The Disposal of the Sewage and Protection of the Water Supply of the City of Milwaukee.* (Abstract of Report to the City Council.) (86) May 24.

Influence of Underdrainage on Spring Floods. W. H. Day. (From Report of Minister of Agriculture, Ontario.) (96) May 25.

New Sewage Disposal Works and Pumping Station, Stratford-Upon-Avon. H. D. Bell. (Paper read before the Inst. of Mun. and County Engrs.) (104) May 26.

Heat Calculations in Factory Heating. H. C. Russell. (101) Serial beginning May 27.

Heating, Ventilating and Air-Washing Plant in the John B. Stetson Company's Building, Philadelphia.* (70) June.

The Experimental Imhoff Sewage-Clarification Tank at Philadelphia and the Original Tanks in the Emscher District of Germany, with Introduction by Rudolph Hering, M. Am. Soc. C. E.* Charles Saville. (13) June 1.

A Smoke Dissipating Chimney.* (Abstract from *Die Umschau*.) (46) June 3.

Specifications for Open Drainage Ditches, Drain Tile and Tile Drainage Ditching. S. F. Moeller. (86) June 7.

Street Dust and Street Cleaning in Relation to Health, Comfort, and Economy. J. H. Landis. (Paper read before the State and Local Boards of Health of Ohio.) (96) June 8.

Hypochlorite Disinfection of Indoor Swimming Tank, at Northwestern University. W. Lee Lewis. (13) June 8.

Valves for Fractional Radiator Heating.* (101) June 10.

Methods and Cost of Constructing a Submerged Sewer Outfall into a Stream. J. C. Schneidwind. (86) June 14.

Furnace Heating of Residence in Russia.* (101) June 17.

Sewage-Disposal Plant at Santa Clara.* (14) June 17.

Typhoid Fever Epidemic at Erie.* C. A. Jennings. (14) June 17.

Water-Supply and Sewerage of the National Rifle Range, Camp Perry, Ohio.* R. Winthrop Pratt, M. Am. Soc. C. E. (13) June 22.

Constructing a Concrete Storm Sewer at Montgomery.* G. C. Bayles. (14) June 24.

The Treatment of the Govan Sewage.* W. C. Easton. (Paper read before the Inst. of Mun. and County Engrs.) (96) June 29; (104) June 2; (14) June 3; (104) Serial beginning June 9.

The Discharge of Unpurified Sewage into the Hudson River near Yonkers.* W. M. Black. (100) July.

Vitrified Pipe vs. Concrete.* E. Argo. (Abstract of paper read before the Ill. Soc. of Engrs. and Survs.) (76) July 1.

Sewage Disposal at Pleasanton, California.* (14) July 1.

Sewage Purification Results at Plainfield during 1910-11. R. S. Lanphear. (14) July 1.

Coefficients of Heat Transmission. R. Allen. (Abstract of paper read before the National Dist. Heating Assoc.) (64) July 1; (47) July 21.

Operation and Extension of Sewage Disposal Works, Reading, Pa.* (86) July 5.

An Economic Study of Garbage Disposal with Special Reference to Conditions in Davenport, Iowa. John W. Alvord. (86) July 5.

General Specifications for the Construction of Open Drainage Ditches. (86) July 5.

Protection of River and Harbor Water from Municipal Wastes.* Charles-Edward Amory Winslow. (19) July 8.

Heating, Ventilating and Power Plant, Boston Opera House.* Charles L. Hubbard. (14) July 15.

Some Extracts from the Report on the Epidemic of Typhoid Fever in the City of Ottawa, Ont., 1911. (96) July 27.

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A Curious Case of Erosion in Storm Water Sewers and its Explanation.* W. K. Palmer. (86) July 12.
Standards of Safety in Relation to Machinery.* David S. Beyer. (20) Serial beginning July 13.
Intercepting Sewers and Stream Improvements at Syracuse, N. Y.* Stephen B. Vernon, Assoc. M. Am. Soc. C. E. (13) July 13.
Horse-Power Rating of Heating Apparatus.* Frank L. Busey. (Paper read before the Amer. Soc. Heating and Ventilating Engrs.) (101) July 14.
Standard Plans and Specifications for Sewers, Seattle, Wash.* (86) July 26.
A Strong Recommendation for Direct City Construction Instead of Contract Work at New Orleans.* (13) July 27.
East San Jose Sewage Disposal Plant.* (14) July 29.
Harbor Water for Flushing New York Streets. (14) July 29.
The Combustion of Town Refuse.* Francis H. Davies. (64) Aug. 1.
Production et Distribution d'Energie Calorifique à Domicile par Station Centrale Urbaine.* A. Beaurrienne. (32) Apr.
De l'Humidité dans les Constructions et Procédés Nouveaux pour y Remédier.* A. Knapen. (32) Apr.
Le Traitement des Ordures Ménagères par Digestion dans la Vapeur, à Columbus (Ohio, E.-U.).* (33) May 20.
Grösste und kleinste Kanalgefälle. A. Wulsch. (52) May 15.

Structural.

The Evolution of the Weldless Steel Chain.* Alex. G. Strathern, M. I. Mech. E. (Abstract of paper read before the South Wales Inst. of Engrs.) (47) Apr. 28.
Electrolytic Corrosion in Reinforced Concrete. C. Edward Magnusson and G. H. Smith. (42) May.
Subaqueous Concrete Work at Goderich.* (67) May.
Tufa Concrete.* (67) May.
Electrolytic Corrosion of Iron in Concrete.* Charles F. Burgess. (4) May; (96) June 15.
Pneumatic Caisson Piers with Extended Footings.* (14) May 6.
By What Right (Gasholders).* Frank Richards. (14) May 6.
The Rusting of Iron. A. H. Sabin, M. Am. Chem. Soc. (Abstract of paper read before the Brooklyn Engrs. Club.) (13) May 11.
The Manufacture and Properties of Hydrated Lime.* Richard K. Meade. (13) May 11.
Concrete Tanks and How to Make Them.* (96) May 11.
The Reinforcement of Concrete. (12) May 12.
The General Electric No. 74 Machine Shop at Lynn.* (14) May 13.
A Large Reinforced Concrete Factory Building.* (14) May 13.
Depreciation of Quick Lime. Wm. R. Copeland and Walter Sperry. (14) May 13.
The Design of a Timber Treating Plant for Railroad Use.* Chas. C. Anthony. (86) May 17.
A Test for Galvanized Iron to Replace the Copper-Sulphate Method.* W. A. Patrick and W. H. Walker. (13) May 18.
Revision of the Toronto Building By-Law. (96) Serial beginning May 18.
The Twelvetrees Calculator for Reinforced Concrete.* (104) May 19.
The Electrical Equipment of a Modern Theatre.* D. C. M. Hume. (73) Serial beginning May 19.
Theories of Multiple-Way Reinforcement.* E. S. Martin. (14) May 20.
Pneumatic Caisson Foundations, Emigrant Bank Building, New York.* (14) May 20.
Some Experimental Data on the Flexure of Flat Circular Plates Within the Elastic Limit.* P. T. Steinthal. (11) May 26.
Reinforcing the Foundations of the Hanan Building.* (14) May 27.
The Woolworth Building, New York. (14) May 27.
Structural Details in Hotel Rector, New York.* (14) May 27.
The Feasibility of Grouping Timbers for Treatment. W. F. Goltra. (Abstract of paper read before the Wood Preservers' Assoc.) (86) May 31.
A Summary of Practice in Reinforced Concrete Building Construction.* W. H. Morris. (From *Cornell Civil Engineer.*) (86) May 31.
A Comparison of Representative Building Laws Concerning Loads and Stresses. John L. Hall. (Paper read before the Pacific Northwest Soc. of Engrs.) (86) May 31.
Cost of Concrete Foundation for a 24 x 36 In. Nordberg Engine Direct Connected to 300 K. W. Westinghouse Generator. (86) May 31.
The Materials of Paint Manufacture. G. B. Heckel. (3) June.
Cement Stock Houses.* Josiah Gibson. (4) June.
Layout and Operation of a Cement Drain Tile Plant.* C. M. Powell. (67) June.

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The Zagelmeyer System of Casting Hollow Cement Building Blocks.* (67) June.
Reinforced-Concrete Work in Cold Weather.* George C. Newton. (13) June 1.
Cement Tile Experiments at the O. A. C., 1908-9. W. H. Day. (96) June 1.
The Comet Telescopic Mast and Hoist.* (73) June 2.
Serious Injury to a Reinforced-Concrete Building by Electrolysis.* Harold P. Brown, M. Am. Electro-Chem. Soc. (13) June 8.
Further Experiments on the Electrolytic Disintegration of Reinforced Concrete. (13) June 8.
The Design of Wind Bracing in Steel Structures.* J. S. Wilson. (11) June 9.
Painting the Exterior of Wooden Buildings. (14) June 10.
The "Ransome Unit System"; a Separately-Molded Reinforced-Concrete Construction.* Alexis Saurbrey. (13) June 15.
The "Unit System" of Separately-Molded Reinforced-Concrete Members as Applied to a Large Factory Building.* (13) June 15.
State Fair Live-Stock Building at Dallas, Tex., a Novel Arch Roof and Comparison with a Truss Roof.* Howard E. Arthur, M. Am. Soc. C. E. (13) June 15.
A Japanese Test of a Floor.* (14) June 17.
Standard Specification for Retort and Fire-Brick Material. (Report to Inst. of Gas Engrs.) (66) June 20.
Standard Building Regulations for Reinforced Concrete. (Report of Comm. Canadian Cement and Concrete Assoc.) (96) June 22.
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AMERICAN SOCIETY OF CIVIL ENGINEERS
INSTITUTED 1852

PAPERS AND DISCUSSIONS

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ECONOMY IN RECTANGULAR PANELS, USING BEAMS OF CONSTANT CROSS-SECTION.*

By J. S. Branne, Assoc. M. Am. Soc. C. E.

It is claimed by the Engineer that he makes public improvements, or work, possible, by designing structures with the greatest economy consistent with safety, taking into account the first cost, maintenance, and probable life of each structure. In doing this he calls to his aid his entire store of knowledge and experience, in order that, in the general plan, the relatively useless and expensive features may be eliminated, and the truly essential and useful reasons for undertaking the work may be emphasized and kept constantly in mind.

Having arrived at a fairly well-planned working model, the detailed building of the parts proceeds along the lines of the general scheme, but on a smaller scale. At this stage the engineer must rely on his skill in grouping the parts, so as to give the best results for the money to be expended.

The object of this paper is to inquire into the most economical way of grouping the parts in a rectangular panel, such as is formed by two girders and two or more beams, the panel of a floor, or the floor-beams and stringers of a bridge.

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* This paper will not be presented at any meeting, but written communications on the subject are invited for publication with it in *Transactions*.

Although engineering literature abounds with meritorious books on statics and applied mechanics, and with special works relating to structures, and although engineers are more or less familiar with the latest conceptions of strength as well as economy in bodies taken alone, whether they are beams, girders, columns, trusses, or arches, and whether they are simple or not so easily determinate, yet the writer has always been impressed by the fact that economy does not consist simply in using the material in the several parts to their individual best advantage, but that certain relations of parts must be observed in order to obtain the most economical whole. It is a question of give and take, or of the economical balancing of parts. This presents a wide field for investigation, both theoretical and empirical; and, though this paper treats of only a modest class of parts which are quite readily analyzed, yet it is important in an economical sense.

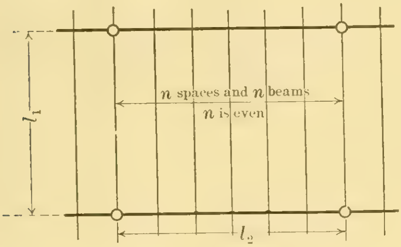


FIG. 1.

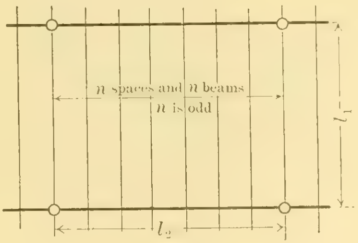


FIG. 2.

Select a rectangular panel from an indefinite number of contiguous panels of the same dimensions: Let its area be $K = l_1\ l_2$, and let the center bending moments on the simply supported beams be M_1 and on the girders M_2. Then, for evenly-distributed loads (Figs. 1 and 2),

$$M_1 = w\ \frac{l_1^2\ l_2}{8}, \text{ and } M_2 = w\ \frac{l_2^2\ l_1}{8} \times \frac{n^2 - 1}{n^2}.$$

Here, w is in pounds per square foot, uniformly distributed, and n is the number of spaces in the panel, equal to the number of beams. When n is even, $\frac{n^2 - 1}{n^2} = 1$. If the price per foot-pound of M_1 is C_1 and of M_2 is C_2, where C_1 and C_2 have any values expressed in the same units of money, then $M_1\ C_1 + M_2\ C_2$ must be a minimum.

By "price per foot-pound" is here meant the cost of the material in beams or girders divided by the respective center bending moments. From this it follows that:

$$l_1 \, K \, C_1 + \frac{K^2}{l_1} \, C_2 = f\,(l_1) \text{ must be a minimum} \ldots\ldots \quad (1A)$$

By taking the minimum value out of this expression and putting its first derivative equal to zero:

$$l_1 \, C_1 = l_2 \, C_2,$$

$$\text{whence } M_1 \, C_1 = M_2 \, C_2 \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

This result might have been foreseen, as the law of the sum of two functions of l_1; but Equation (1A) is developed because it is useful in plotting cost curves. Therefore, the economy in a rectangular panel, where the center bending moment determines the section, and the cross-section is constant, means that the cost of the beams should equal the cost of the girders; or,

$$\underbrace{n \times a_1 \times l_1 \times 12}_{\text{(Cu. in. in beams × cost, 1.)}} = \underbrace{C \times a_2 \times l_2 \times 12}_{\text{(Cu. in. in girder × cost, } C.\text{)}} \ldots\ldots\ldots \quad (2)$$

In order to apply this equation of condition, (2), it may be well to consider carefully what it implies:

First.—It gives the condition of greatest economy for two dependent series of bodies, subject to bending, as explained. The first series—the beams—has an aggregate cross-section per panel of $n \times a_1$ square inches; the second—the girder—has a cross-section of a_2 square inches. Therefore, when beams and girders of certain widths and depths, or weights and depths, are used—all beams being alike, and all girders alike—for the greatest economy, the respective quantities should be equal.

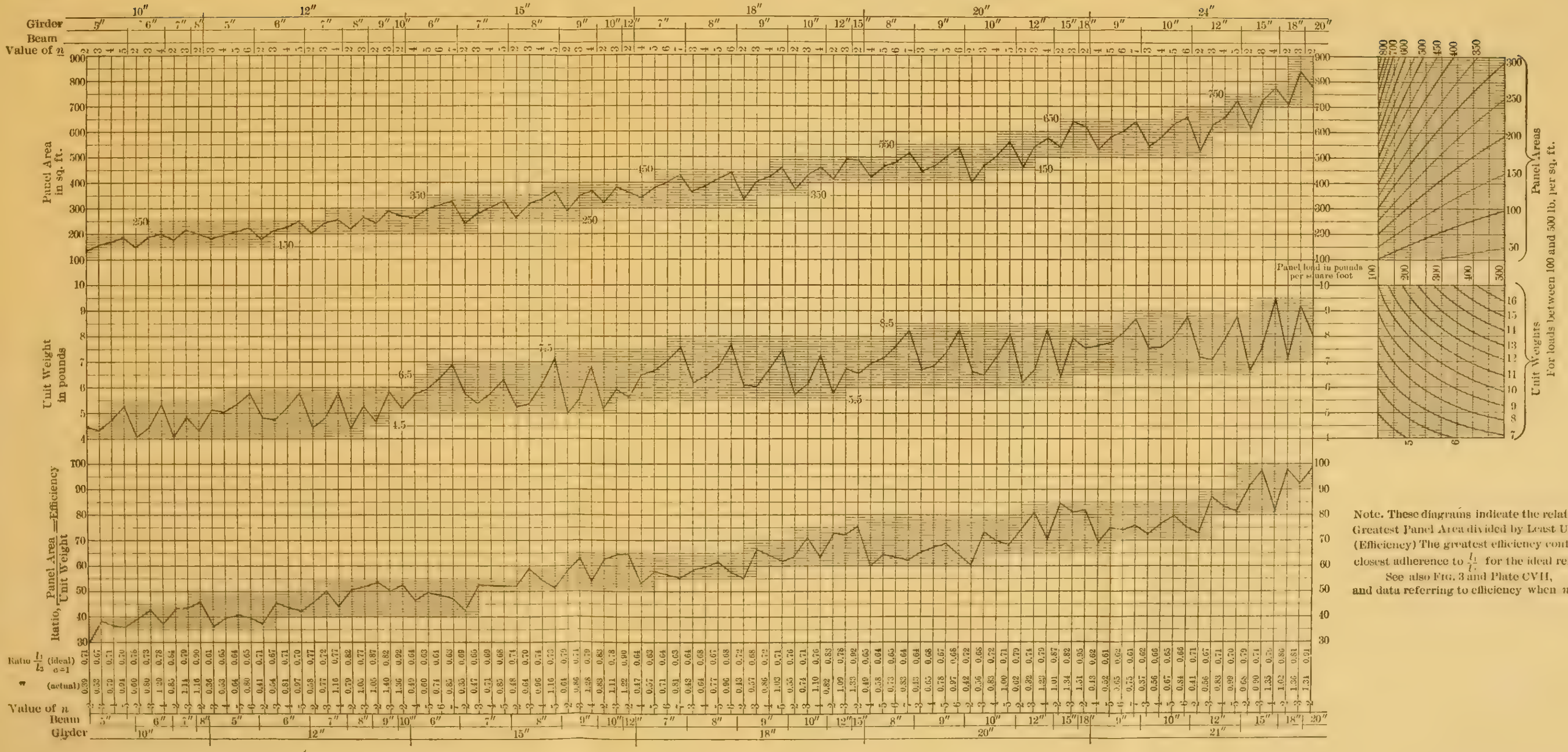
Second.—The uniformly distributed load, w, does not enter into the equation, hence the relation is independent of w. Any rectangular area, K, therefore, for any intensity of floor loading, has a certain economical ratio between its dimensions, l_1 and l_2, depending on the properties of the selected beams and girders; and, if this ratio is adhered to, K is the greatest area that can be had without increasing the quantity of material used per square foot of floor.

The ratio, $\frac{\text{Panel area}}{\text{Unit weight}}$, may be called the "efficiency," and clearly indicates economy.

In the practical application of the principle contained in Equation (2), the panel area, K, may be given, and such depths of beams and

DIAGRAM SHOWING PANEL AREAS, UNIT WEIGHT, AND EFFICIENCY, FOR VARIOUS COMBINATIONS OF BEAMS.

Uniformly distributed load, w_1=100 lb. per sq. ft. All beams minimum-weight sections, as per "Pocket Companion" of Carnegie Steel Company, 1903 edition. Transfer curves show panel areas and unit weights for larger loads.



Note. These diagrams indicate the relation: Greatest Panel Area divided by Least Unit Weight (Efficiency) The greatest efficiency conforms with closest adherence to $\frac{l_1}{l_3}$ for the ideal relation.

See also FIG. 3 and Plate CVII, and data referring to efficiency when $n-3$.

girders as may be determined by other considerations, as, for example, head-room; or l_1 and l_2 may be given, whence the ratio of depths of beams and girders can be found. Naturally, there are many other ways in which the problem may come up. Again, the ideal relation expressed by Equation (2) may be realized only in beams and girders made of plastic materials, as concrete; or of metals, cast to proper size. If the beams and girders are of wood, the difficulty of reaching the ideal condition of Equation (2) is not great, as the widths can be varied, and there are generally many beams or joints which may aggregate the right amount. If rolled-steel beams are used, however, such adjustment is difficult, because, after selecting certain depths, one girder can seldom be found to match an integral number of beams.

To illustrate the practical working of the relation given in Equation (2), assume that the panel area, K, has been determined as some general size which appears to suit the case, as to magnitude; and that beams and girders of constant rectangular cross-section have been selected, of depths, h_1 and h_2, respectively, with extreme fiber stresses, f_1 and f_2. Then, from the general formulas for bending, and incorporating the relation in Equation (2):

$$l_2 = \sqrt[4]{K^2 \frac{f_2 h_2}{C f_1 h_1} \times \frac{n^2}{n^2 - 1}}$$

$$\text{and } l_1 = \sqrt[4]{K^2 \frac{C f_1 h_1}{f_2 h_2} \times \frac{n^2 - 1}{n^2}}$$

$$\text{whence } \frac{l_1}{l_2} = \sqrt{\frac{C f_1 h_1}{f_2 h_2} \times \frac{n^2 - 1}{n^2}} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (3)$$

Here, $\frac{n^2 - 1}{n^2}$, or its reciprocal, disappears if n is even. If, as a special case, $f_1 = f_2$, and $C = 1$, indicating beams and girders of the same materials, and having the same unit cost, then:

$$\frac{l_1}{l_2} = \sqrt{\frac{h_1}{h_2} \times \frac{n^2 - 1}{n^2}}_{\;(n \text{ odd})} = \sqrt{\frac{h_1}{h_2}}_{\;(n \text{ even})}$$

From these relations, suitable diagrams may be drawn, and, by developing definite values for l_1 and l_2, for a floor load, $w = 100$ lb., as a value easily worked with, transfer curves can be drawn, showing at a glance how the materials may be used to their best advantage in bending.

The direct question as to the depths of the beams and girders to be used in a certain case can only be determined by grouping many other parts, such as head-room, available materials, increase or decrease of the cost of other component parts in the structure, etc. Thus, in a tall building, a deeper floor makes it necessary to have greater quantities in nearly all the other parts, and there is often a direct increase in the dead weight of the floor.

As to the direct question of size of panel, the quantity, K, varies. The unit cubic contents of the panel may be put equal to

$$108\, w \left(\frac{l_1^2}{f_1\, h_1} + \frac{l_2^2}{f_2\, h_2} \times C \right).$$

This quantity increases and decreases with K, if the economic relation of l_1 and l_2 is constant. Of course, if there is a deviation from this, even a smaller panel may have greater unit cubic contents.

Regarding the value of n: naturally, in any panel, if the material apportioned to the beams can be divided by three, or $n = 3$, this makes the best possible arrangement for beams of constant cross-section, because, in that case, the entire middle third of the girder is used to its full capacity in bending.

In the ideal panel, when $n = 3$, there is a saving of about 5% over any arrangement in which n is even. When $n = 5$, the advantage of the odd number is almost negligible.

If rolled-steel beams are used (and proceeding in the same manner as with beams of rectangular cross-section), it will be found that:

$$l_2 = \sqrt[4]{K^2 \frac{r_2}{C\, r_1} \times \frac{n^2}{n^2 - 1}}$$

$$\text{and } l_1 = \sqrt[4]{K^2 \frac{C\, r_1}{r_2} \times \frac{n^2 - 1}{n^2}}$$

$$\text{whence } \frac{l_1}{l_2} = \sqrt{\frac{C\, r_1}{r_2} \times \frac{n^2 - 1}{n^2}} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (4)$$

Here, $\frac{n^2 - 1}{n^2}$, or its reciprocal, disappears when n is even. The ratio, $\frac{r}{h}$, has been assumed to be constant $\left(\frac{4}{10}\right)$. This is nearly right for sections of minimum weight. If certain beams and girders having radii of gyration, r_1 and r_2, are selected, the difficulty is that the girder seldom will match an integral number of beams. The inquiry may

PLATE CVII.
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BRANNE ON
ECONOMY IN RECTANGULAR PANELS.

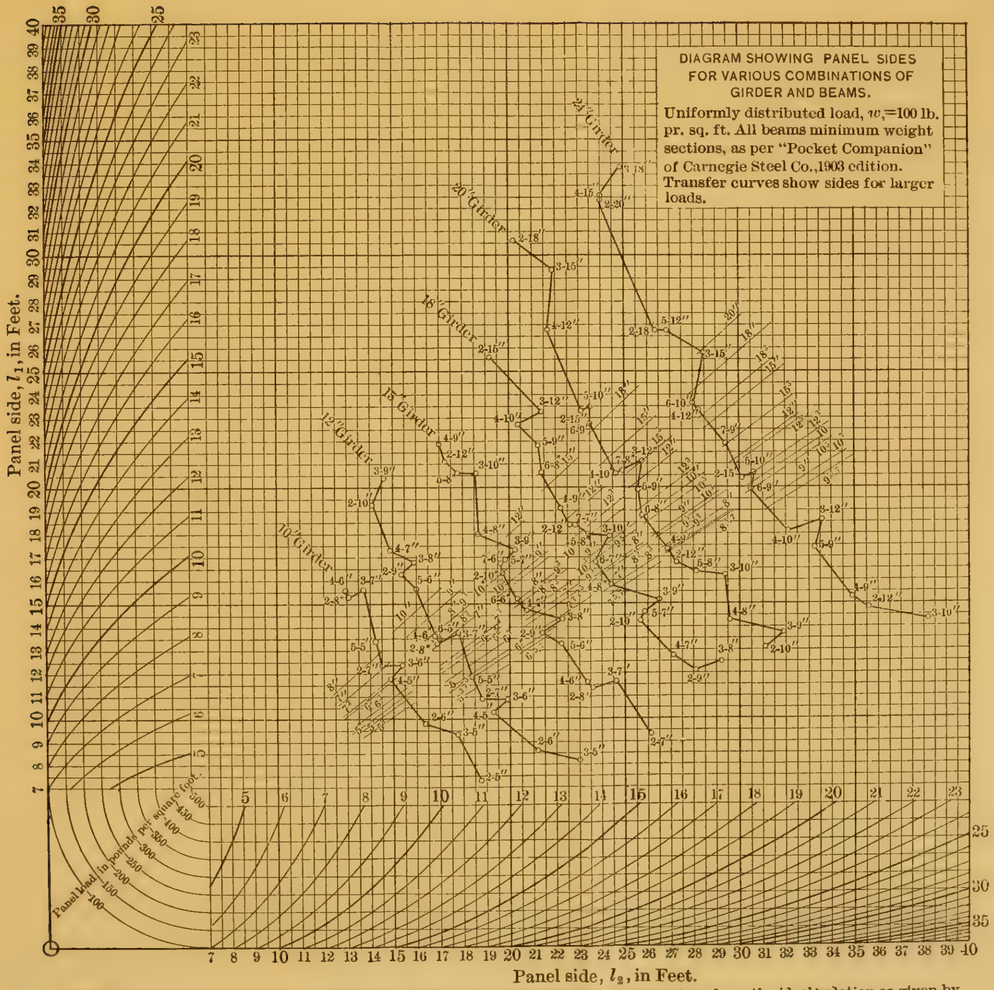

DIAGRAM SHOWING PANEL SIDES
FOR VARIOUS COMBINATIONS OF
GIRDER AND BEAMS.

Uniformly distributed load, w_1=100 lb. pr. sq. ft. All beams minimum weight sections, as per "Pocket Companion" of Carnegie Steel Co., 1903 edition. Transfer curves show sides for larger loads.

Note. The object of this diagram is to show the divergence of several beam combinations from the ideal relation as given by $\frac{l_1}{l_2} = \sqrt{cr_1 \div r_2}$ when n is even, or $\frac{l_1}{l_2} = \sqrt{cr_1 \div r_2}\sqrt{(n^2-1) \div n^2}$ when n is odd. The ideal relations are drawn as fine lines.

then best be directed toward finding which value of n brings the combination nearest to the ideal relation.

Using the general formulas for bending, and incorporating the relation in Equations (2) or (4):

$$N = \frac{S_2}{S_1}\sqrt{\frac{C\,r_1}{r_2} \times \frac{n^2}{n^2-1}} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (5)$$

Here, N represents the theoretical number of beams required in the ideal panel, and is generally fractional. S_2 and S_1 are the section moduli of girders and beams, respectively; and $\frac{n^2}{n^2-1}$ disappears when n is even. Therefore, the integral number nearest to N will be the best number of beams to use, bearing in mind that one should investigate the relations of one girder and several beams, all of definite properties.

If N is close to the numbers, 2 or 4, it is nevertheless quite likely that a three-space panel will give the greater efficiency $\left(\frac{\text{Panel area}}{\text{Unit weight}}\right)$. Similarly, if N is nearer to 4 or 6 than to 5, a five-space panel may show the greater efficiency, for the reasons stated previously. Selecting, then, this n which is close to N, the general formula for bending gives:

$$(\text{when } n \text{ is even})\ \frac{l_1}{l_2} = n\,\frac{S_1}{S_2}$$

$$(\text{when } n \text{ is odd})\ \frac{l_1}{l_2} = \frac{n^2-1}{n} \times \frac{S_1}{S_2}\,.$$

These are the actual relations, or as near as one can get to the ideal ones.

As to the value of C, this will probably be between 0.94 and 1.00, considering cost of fabricated material only; but if cost of erection is taken into account, the cost of the beams will be higher, owing to the placing of more pieces, and C may be as low as 0.80.

For intensities of floor loading other than w,

$${l_2}_{w_1} = {l_2}_{w}\sqrt[3]{\frac{w}{w_1}},\quad {l_1}_{w_1} = {l_1}_{w}\sqrt[3]{\frac{w}{w_1}}.$$

$${l_1}_{w_1}\,{l_2}_{w_1} = K_{w_1} = {l_1}_{w}\,{l_2}_{w}\sqrt[3]{\frac{w^2}{{w_1}^2}}$$

$$\text{Unit weight}_{w_1} = \text{Unit weight}_{w}\sqrt[3]{\frac{w_1}{w}}.$$

When the shape of the panel is practically fixed by the prevailing conditions, the ideal relations may serve to indicate the most economical flooring, long or short span, tile or concrete. When the shape of the panel approaches a square, it may indicate long span construction.

Plates CVI and CVII, and Fig. 3, show graphically the relations existing in rectangular panels, and these relations are illustrated by a few combinations of rolled girders and beams. w has been assumed to be 100 lb. per sq. ft.

Plate CVI shows areas, weights, and ratios. The curves are self-explanatory, the upper two being drawn to illustrate the lower one, or the efficiency curve, which is the criterion for economy in a panel. The general efficiency of the three-space panel is quite evident, as explained previously.

Fig. 3 gives some cost curves, and illustrates the increment in total panel cost when the ideal relation, $\frac{l_1}{l_2}$, is deviated from in either direction. The "Total Panel Cost" is here plotted for various combinations of beams with a 15-in. girder, using Equation (1A). The following assumptions are made for the purpose of graphical illustration:

> Unit cost of girder = Unit cost of beam (or, $C = 1$);
> This unit cost has been put at 2 cents per lb.

Thus a 10-in. beam at 25 lb. per ft., in 1 ft. of its length, takes care of $(24.4 \times 1\,333) = 32\,500$ ft-lb. Here 24.4 is the section modulus. The cost of the beam per foot is $25 \times 2 = 50$ cents; or, the cost of the entire beam is $(50 \times l_1)$ cents. Therefore $(50 \times l_1)$ divided by $32\,500$ is the "Cost per foot-pound," as understood by C_1 in Equation (1A).

Similarly, for the 15-in. girder: $(84 \times l_2)$ divided by $78\,700$ is C_2. Introducing this in Equation (1A), we get

$$l_1 \; K \frac{50 \; l_1}{32\,500} + \frac{K^2}{l_1} \times \frac{84 \; l_2}{78\,700} = f \; (l_1),$$

which reduces to

$$\frac{1.54 \; l_1^2 \; K}{1\,000} + \frac{1.065 \; K^3}{1\,000 \; l_1^2} = f \; (l_1).$$

The cost for the 9, 8, 7, and 6-in. beams is found in a similar manner.

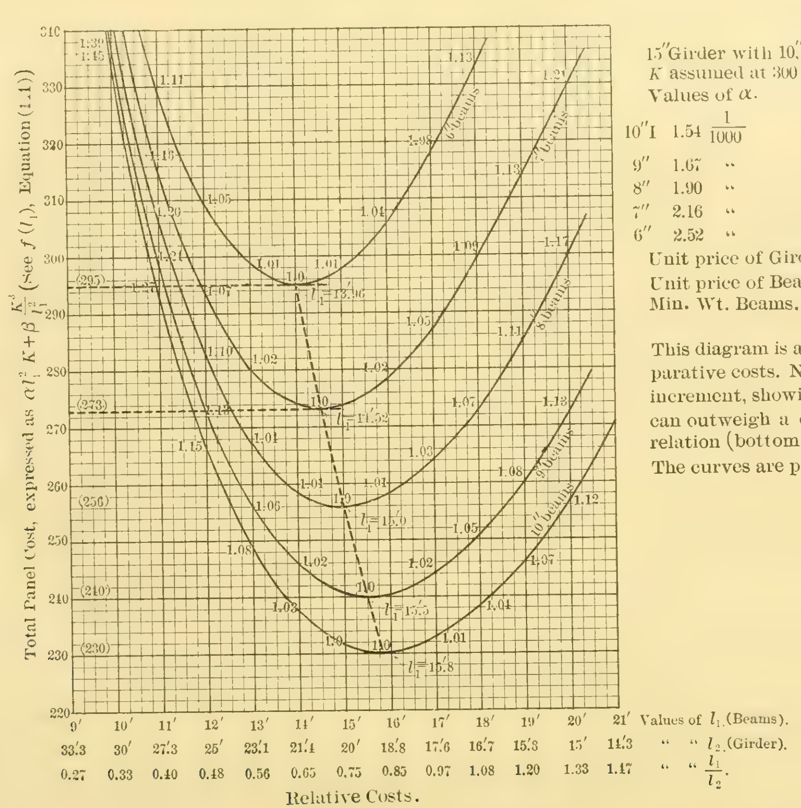

FIG. 3.

15" Girder with 10", 9", 8", 7", 6" beams. n even.
K assumed at 300 sq. ft.

	Values of α.	Values of β.
10" I	$1.54 \frac{1}{1000}$	$1.065 \frac{1}{1000}$
9"	1.67 "	"
8"	1.90 "	"
7"	2.16 "	"
6"	2.52 "	"

Unit price of Girder assumed the same as Unit price of Beams. ($c = 1$).
Min. Wt. Beams.

This diagram is a representation of comparative costs. Note the percentage of increment, showing how the relation, $n=3$, can outweigh a deviation from the ideal relation (bottom of curve).
The curves are plotted for n even.

The "Total Panel Cost" at the left of Fig. 3 is in cents, and must be multiplied by $\frac{w}{8}$ for practical use. Note that these curves are plotted for n even. On Plate CVI it will be noticed that the only 10-in. relation plotted for n even is $n = 2$; also that the relation, $\frac{l_1}{l_2}$, is the ideal one; hence the cost at the bottom of the curve on Fig. 3 gives 230 cents with $K = 300$.

On Plate CVI, the curve for "Panel Areas," using the transmission curve on the right, indicates a unit load of 112.5 lb. From the "Unit Weight" curve it is found that this corresponds to a weight of $5\frac{1}{3}$ lb., or 1 600 lb. for a panel area of 300 sq. ft., which, at 2 cents per lb., makes \$32. Now, from Fig. 3, 230 cents $\times \frac{112\frac{1}{2}}{8} = \$32.33$. This is fairly close, for the small scale on which the diagram is plotted, and is one more example of the economy of graphical work. The same conformity will be found by actually computing the quantities from Plate CVII.

Considering now the relation when $n = 3$, it is noted that the ideal panel relation is violated, giving $\frac{l_1}{l_2} \doteq 1.11$, instead of 0.78; yet the efficiency is greater. Fig. 3 shows a rise in cost from 1 to 1.045, or $4\frac{1}{2}\%$, which is slightly outweighed by the intrinsic cheapness of the three-space panel, which gives a saving of one-ninth in the girder, or about 11%, or $5\frac{1}{2}\%$ on the whole panel weight, if weight of beams = weight of girders.

In this case the weight of the girder is 43% of the panel weight, or the saving on the entire panel is 4.77%, thus showing a slight advantage over $n = 2$.

Clearly, the three-space panel is the cheapest of all; the next is $n = 5$ and then $n = 7$, which latter, as to efficiency, approaches $n = \infty$, or uniform loading.

Plate CVII shows several combinations, and indicates their greater or lesser economy as they approach or recede from the ideal relations, indicated by the fine lines drawn from the origin. The transfer curves are drawn from the relations previously stated.

It may be that where the combinations fall below the ideal ratio, $\sqrt{\frac{r_1}{r_2}}$, better results may be had by using weights greater than the minimum, for the beams; and, if above the ratio, by using girders of greater weight. These greater weights are generally (but not always) produced by spreading the rolls, thus resulting in smaller inertias, relatively, than the minimum weights, whence they are not quite as economical as the minimum weights, speaking now of bending only, and not considering their valuable properties in being better able to carry shear for heavy loads, short spans, or special considerations. By plotting a few, this could be easily determined.

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PAPERS AND DISCUSSIONS

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ECONOMIC CANAL LOCATION IN UNIFORM COUNTRIES.

By Lyman E. Bishop, Jun. Am. Soc. C. E.

To be Presented September 20th, 1911.

General Remarks.

As the writer has spent practically all his time, for the past three years, in the field location of canals and laterals, the method of economic location which has been developed may be of passing interest to others engaged in work of this class.

Yardage diagrams were made of standard canal sections with capacities of from 1 200 to 25 sec-ft. and a velocity of 2.5 ft. per sec. For capacities ranging from 1 200 to 250 sec-ft., the diagrams were of sections having intervals of 50 sec-ft.; for capacities of less than 250 sec-ft., a diagram was made for each interval of 25 sec-ft. Figs. 1 and 2 are typical sections, and Table 1 gives the dimensions of standard laterals having velocities of from 1.0 to 3.0 ft. per sec. and capacities of from 1 to 90 sec-ft.

In the yardage diagrams, Figs. 1 and 2, the center cut on a given transverse ground slope is used as the argument for the excavation and embankment for a required canal section, the elements of which section are predetermined. The quantities are given in cubic yards per station of 100 ft. The embankment quantities are 10% in excess

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Note.—These papers are issued before the date set for presentation and discussion. Correspondence is invited from those who cannot be present at the meeting and may be sent by mail to the Secretary. Discussion, either oral or written, will be published in a subsequent number of *Proceedings*, and, when finally closed, the papers, with discussion in full, will be published in *Transactions*.

of the actual embankment, this being an arbitrary allowance for shrinkage and settlement. The center cuts vary from 6 ft. below the bottom of the canal to 16 ft. above grade, and the transverse ground slopes from the level to 35%, and is platted at 5% intervals.

Two embankment curves are plotted for each different transverse slope; one gives the total yardage in the upper and lower banks combined; the other gives the yardage in the lower bank alone. These two curves join or coincide at the center-line cut, where the inside crown of the upper bank intersects the ground surface.

Whenever the full water level of the canal intersects the ground surface below the outside toe of the upper bank, the upper bank is discontinued. The note on each diagram (Figs. 1 and 2), "Do not stake out upper bank where water line intersects ground line within .... feet of center line," indicates where this condition prevails. This point is also indicated on the diagrams by a heavy horizontal line connecting the one-bank curve with the two-bank curve of the same transverse slope, and is supplemented by an explanatory note: "These breaks indicate center line cut at which upper bank is dropped."

Under ordinary conditions of regular location, greater center cuts require one bank only, while lighter center cuts require two banks. These requirements will always be governed by the full lines of the embankment curve. When, for any reason, the lower bank only is required, the dotted line below the horizontal line connecting the same transverse slope is used. When it is required to continue the upper bank beyond the point provided for under ordinary conditions, the dotted line above the horizontal connecting line is used.

Where the embankment curve for a given transverse slope intersects the excavation curve of the same transverse slope, the intersection center cut is called "economic" and is so indicated on the diagrams. At these intersections the yardages in excavation and embankment are balanced, allowance having been made for shrinkage and settlement of the embankment quantities.

At the right of each diagram a template of the canal shows the dimensions and the elements which govern the quantities given in the diagram. The elements, *n, s,* and *v* (Basin or Kutter formula), may be varied to meet the requirements of the engineer, and will determine the dimensions of the section required. The dimensions alone govern the quantities in any section diagram. It is only necessary, therefore,

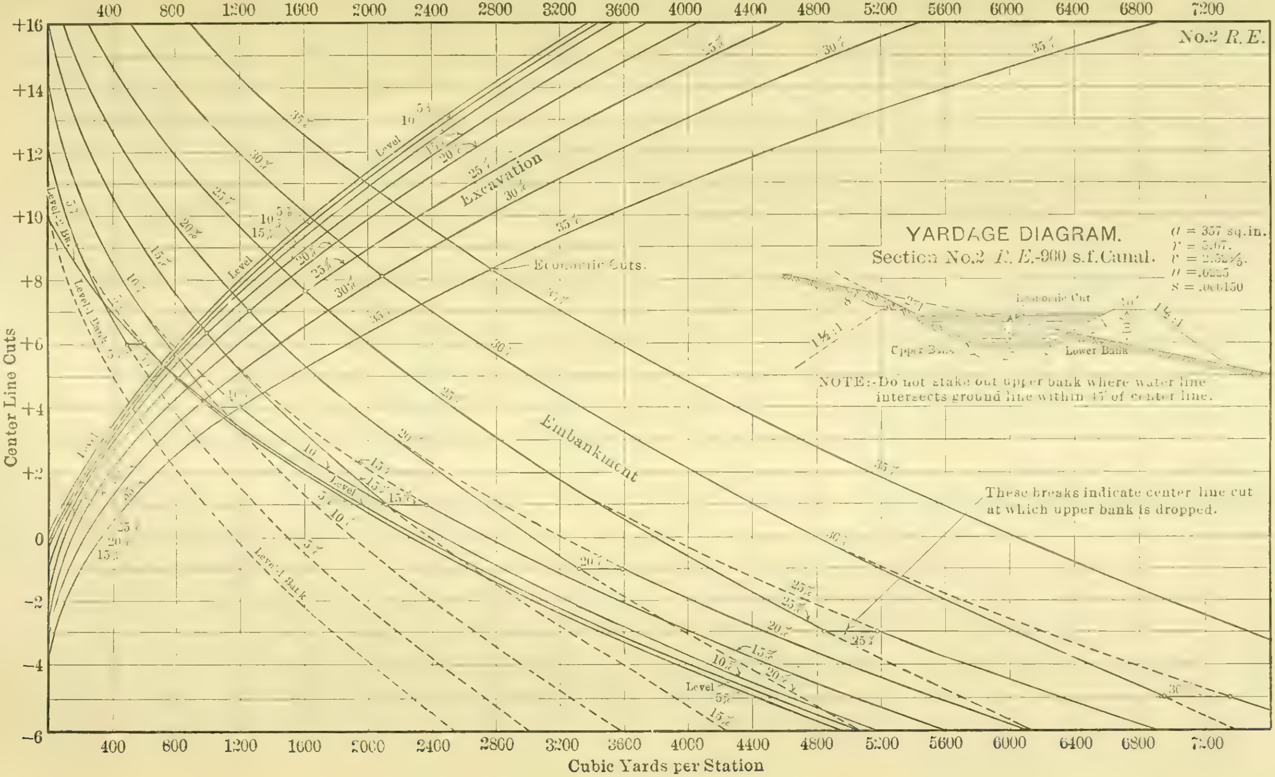
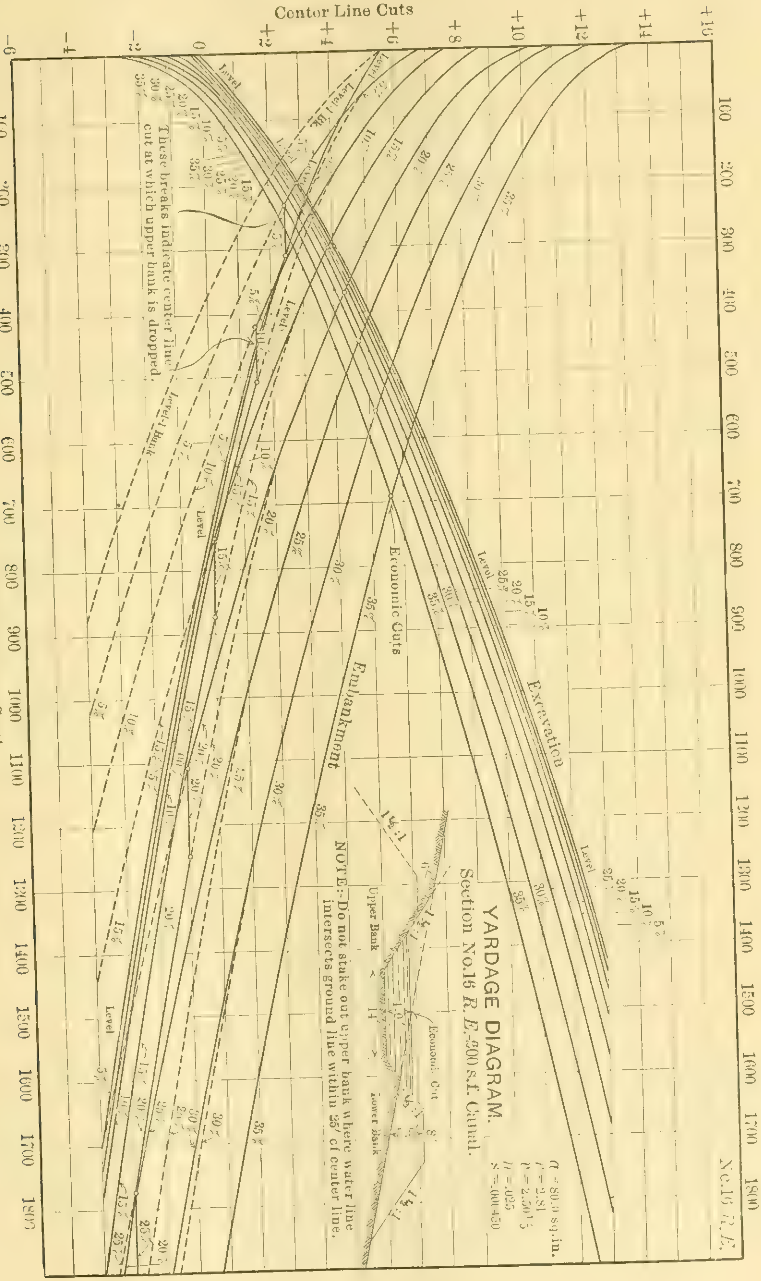

No.2 R.E.
YARDAGE DIAGRAM.
Section No.2 R.E.-900 s.f.Canal.
a = 357 sq.in.
r = 5.67.
v = 2.52/s.
n = .0225
s = .000150
Economic Cut
Upper Bank
Lower Bank
1½:1
2:1
10′
NOTE:-Do not stake out upper bank where water line intersects ground line within 45′ of center line.
These breaks indicate center line cut at which upper bank is dropped.
Economic Cuts.
Excavation
Embankment
Level
Level 2 Bk.
Level 1 Bank
5%
10%
15%
20%
25%
30%
35%
Center Line Cuts
+16
+14
+12
+10
+8
+6
+4
+2
0
−2
−4
−6
Cubic Yards per Station
400
800
1200
1600
2000
2400
2800
3200
3600
4000
4400
4800
5200
5600
6000
6400
6800
7200

FIG. 1.



YARDAGE DIAGRAM.
Section No.15 *R. E.* 200 s.f. Canal.

NOTE:- Do not stake out upper bank where water line intersects ground line within 25' of center line.

These breaks indicate center line cut at which upper bank is dropped.

Fig. 2.

TABLE 1.—(*Continued.*)

Section.	*E. C.*	0.75 : 1 000		1 : 1 000		1.5 : 1 000		2 : 1 000		2.5 : 1 000		3 : 1 000		4 : 1 000		5 : 1 000		6 : 1 000		7 : 1 000		8 : 1 000		9 : 1 000		Cubic yards, 100 ft. Sta.	*B*	*F*	*T*	*W*	*P*	*A*	*R*
		V	*D*	*V*	*D*	*V*	*D*	*V*	*D*	*V*	*D*	*V*	*D*	*V*	*D*	*V*	*D*	*V*	*D*	*V*	*D*	*V*	*D*	*V*	*D*								
36	1.6	1.70	28.7	1.95	32.9	2.40	40.5	2.75	46.4	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	67.6	9.0	1.5	4.0	1.50	14.4	16.87	1.17
37	1.6	1.70	30.0	2.00	35.2	2.45	43.2	2.80	49.3	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	70.5	9.5	1.5	4.0	1.50	14.9	17.62	1.18
38	1.6	1.70	31.2	2.00	37.7	2.45	45.0	2.80	51.4	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	73.5	10.0	1.5	4.0	1.50	15.4	18.37	1.19
39	2.0	1.70	22.7	2.00	26.7	2.45	32.7	2.85	38.1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	59.3	5.0	1.5	4.0	1.75	11.3	13.35	1.18
40	1.9	1.75	26.6	2.00	30.4	2.50	38.0	2.90	44.1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	62.3	6.0	1.5	4.0	1.75	12.3	15.20	1.23
41	1.9	1.80	30.2	2.05	34.4	2.50	42.0	2.95	49.6	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	69.3	7.0	1.5	4.0	1.75	13.3	16.80	1.26
42	1.8	1.85	34.6	2.10	39.3	2.60	48.7	3.00	56.1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	71.3	8.0	1.5	4.0	1.75	14.3	18.70	1.31
43	1.8	1.90	38.6	2.15	43.7	2.65	54.0	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	78.0	9.0	1.5	4.0	1.75	15.3	20.35	1.33
44	1.7	1.90	42.0	2.20	48.6	2.70	59.7	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	79.0	10.0	1.5	4.0	1.75	16.3	22.10	1.35
45	1.7	1.90	45.3	2.20	52.4	2.70	64.3	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	85.3	11.0	1.5	4.0	1.75	17.3	23.80	1.37
46	1.6	1.95	50.0	2.25	57.6	2.75	70.5	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	85.3	12.0	1.5	4.0	1.75	18.3	25.60	1.40
47	2.2	1.85	29.6	2.15	34.4	2.60	41.6	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	67.6	5.0	1.5	4.0	2.00	12.2	16.60	1.31
48	2.1	1.90	34.2	2.20	39.6	2.70	48.6	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	71.2	6.0	1.5	4.0	2.00	13.2	18.00	1.36
49	2.0	1.95	39.0	2.25	45.0	2.75	55.0	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	74.1	7.0	1.5	4.0	2.00	14.2	20.00	1.41
50	2.0	2.00	44.0	2.30	50.6	2.85	62.7	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	81.5	8.0	1.5	4.0	2.00	15.2	22.00	1.45
51	1.9	2.05	49.2	2.35	56.4	2.90	69.6	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	83.4	9.0	1.5	4.0	2.00	16.2	24.00	1.48
52	1.9	2.05	53.3	2.40	62.5	2.90	75.4	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	90.4	10.0	1.5	4.0	2.00	17.2	26.00	1.51
53	1.8	2.10	58.8	2.40	67.3	2.95	82.6	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	91.3	11.0	1.5	4.0	2.00	18.2	28.00	1.54
54	1.8	2.10	63.0	2.45	73.5	3.00	90.0	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	98.0	12.0	1.5	4.0	2.00	19.2	30.00	1.56

In Kutter's Formula $n = 0.025$.

T = Width of Top of Bank, in feet.

D = Discharge, in cubic feet per second.

P = Wetted Perimeter, in feet.

E. C. = Economic Cut, Level Section.

W = Depth of Water, in feet.

B = Width of Bottom, in feet.

A = Area of Cross-Section, in square feet.

F = Distance, Top of Water to Top of Bank, in feet.

V = Velocity of Water, in feet per second.

All slopes 1½ : 1.

R = Hydraulic Radius.

TABLE 1.—Dimensions of Standard Laterals.

Velocities and Discharges for Different Slopes.

Section.	*E. C.*	0.75 : 1 000		1 : 1 000		1.5 : 1 000		2 : 1 000		2.5 : 1 000		3 : 1 000		4 : 1 000		5 : 1 000		6 : 1 000		7 : 1 000		8 : 1 000		9 : 1 000		Cubic yards, 100-ft. Sta.	*B*	*F*	*T*	*W*	*P*	*A*	*R*
		V	*D*	*V*	*D*	*V*	*D*	*V*	*D*	*V*	*D*	*V*	*D*	*V*	*D*	*V*	*D*	*V*	*D*	*V*	*D*	*V*	*D*	*V*	*D*								
1	1.1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	2.0	2.3	2.2	2.5	12.8	1.5	1.0	3.0	0.5	3.3	1.125	0.34
2	1.1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	2.0	2.8	2.2	3.0	2.3	3.2	14.9	2.0	1.0	3.0	0.5	3.8	1.375	0.36
3	1.2	....	....	1.00	2.3	....	....	1.4	3.3	....	....	1.7	4.0	2.0	4.7	2.3	5.4	2.5	5.9	2.7	6.3	2.8	6.6	3.0	7.0	16.9	2.0	1.0	3.0	0.75	4.7	2.34	0.50
4	1.2	....	....	1.00	2.7	....	....	1.5	4.1	....	....	1.8	4.9	2.1	5.7	2.4	6.5	2.6	7.1	2.8	7.6	3.0	8.2	....	....	19.1	2.5	1.0	3.0	0.75	5.2	2.72	0.52
5	1.2	....	....	1.10	3.4	....	....	1.5	4.5	....	....	1.9	5.9	2.2	6.8	2.4	7.4	2.7	8.4	2.8	8.7	3.0	9.3	....	....	21.3	3.0	1.0	3.0	0.75	5.7	3.09	0.54
6	1.1	....	....	1.10	3.8	....	....	1.6	5.5	....	....	1.9	6.5	2.3	7.9	2.5	8.6	2.8	9.7	3.0	10.3	....	....	....	....	21.0	3.5	1.0	3.0	0.75	6.2	3.45	0.56
7	1.1	....	....	1.10	4.2	....	....	1.6	6.1	....	....	1.9	7.3	2.3	8.8	2.5	9.6	2.8	10.8	3.0	11.5	....	....	....	....	23.0	4.0	1.0	3.0	0.75	6.7	3.84	0.57
8	1.1	....	....	1.20	5.0	....	....	1.7	7.2	....	....	2.0	8.5	2.3	9.7	2.6	11.0	2.8	11.8	....	....	....	....	....	....	25.1	4.5	1.0	3.0	0.75	7.2	4.22	0.59
9	1.0	....	....	1.20	5.5	....	....	1.7	7.8	....	....	2.0	9.2	2.4	11.0	2.6	11.9	2.9	13.3	....	....	....	....	....	....	24.1	5.0	1.0	3.0	0.75	7.7	4.59	0.60
10	1.3	1.00	4.5	1.30	5.8	1.60	7.3	1.8	8.1	2.1	9.5	2.3	10.4	2.7	12.2	3.0	13.5	....	....	....	....	....	....	....	....	23.8	3.0	1.0	3.0	1.0	6.6	4.50	0.68
11	1.3	1.15	5.7	1.30	6.5	1.60	8.1	1.9	9.5	2.1	10.5	2.3	11.5	2.7	13.5	3.0	15.0	....	....	....	....	....	....	....	....	26.3	3.5	1.0	3.0	1.0	7.1	5.00	0.70
12	1.3	1.15	6.3	1.30	7.1	1.60	9.0	1.9	10.4	2.1	11.5	2.3	12.9	2.7	15.1	....	....	....	....	....	....	....	....	....	....	28.6	4.0	1.0	3.0	1.0	7.6	5.50	0.72
13	1.2	1.20	7.2	1.40	8.4	1.70	10.2	1.9	11.4	2.2	13.2	2.4	14.4	2.8	16.8	....	....	....	....	....	....	....	....	....	....	28.0	4.5	1.0	3.0	1.0	8.1	6.00	0.74
14	1.2	1.20	7.8	1.40	9.1	1.70	11.0	2.0	13.0	2.2	14.3	2.4	15.6	2.8	18.2	....	....	....	....	....	....	....	....	....	....	30.2	5.0	1.0	3.0	1.0	8.6	6.50	0.76
15	1.2	1.20	8.4	1.40	9.8	1.75	12.2	2.0	14.0	2.25	15.7	2.5	17.5	2.9	20.3	....	....	....	....	....	....	....	....	....	....	32.4	5.5	1.0	3.0	1.0	9.1	7.00	0.77
16	1.1	1.25	9.3	1.40	10.5	1.80	13.5	2.0	15.0	2.30	17.2	2.5	18.8	2.9	21.8	....	....	....	....	....	....	....	....	....	....	31.2	6.0	1.0	3.0	1.0	9.6	7.50	0.78
17	1.3	1.30	9.5	1.50	11.0	1.90	13.9	2.2	16.1	2.45	18.0	2.7	19.8	....	....	....	....	....	....	....	....	....	....	....	....	28.6	4.0	1.0	3.0	1.25	8.5	7.34	0.86
18	1.3	1.35	10.7	1.60	12.7	1.95	15.5	2.25	17.9	2.50	19.9	2.75	21.9	....	....	....	....	....	....	....	....	....	....	....	....	31.1	4.5	1.0	3.0	1.25	9.0	7.97	0.88
19	1.3	1.40	12.0	1.60	13.7	2.00	17.1	2.30	19.8	2.55	21.9	2.80	24.0	....	....	....	....	....	....	....	....	....	....	....	....	53.5	5.0	1.0	3.0	1.25	9.5	8.59	0.90
20	1.3	1.40	12.9	1.60	14.7	2.00	18.4	2.40	22.1	2.55	22.5	2.90	26.8	....	....	....	....	....	....	....	....	....	....	....	....	35.9	5.5	1.0	3.0	1.25	10.0	9.22	0.92
21	1.3	1.40	13.7	1.60	15.7	2.00	19.6	2.40	23.6	2.60	25.5	2.90	28.5	....	....	....	....	....	....	....	....	....	....	....	....	38.3	6.0	1.0	3.0	1.25	10.5	9.84	0.94
22	1.2	1.45	15.2	1.70	17.8	2.05	21.4	2.50	25.6	2.65	27.8	3.00	31.4	....	....	....	....	....	....	....	....	....	....	....	....	36.9	6.5	1.0	3.0	1.25	11.0	10.47	0.95
23	1.2	1.45	16.1	1.70	18.8	2.05	22.7	2.50	27.2	2.65	29.4	3.00	33.3	....	....	....	....	....	....	....	....	....	....	....	....	39.1	7.0	1.0	3.0	1.25	11.5	11.09	0.96
24	1.2	1.45	17.0	1.70	19.9	2.10	24.6	2.50	29.3	2.65	31.0	3.00	35.2	....	....	....	....	....	....	....	....	....	....	....	....	41.3	7.5	1.0	3.0	1.25	12.0	11.72	0.98
25	1.2	1.50	18.5	1.80	22.2	2.10	25.9	2.50	30.9	2.70	33.3	3.00	37.0	....	....	....	....	....	....	....	....	....	....	....	....	43.6	8.0	1.0	3.0	1.25	12.5	12.34	0.99
26	1.5	1.50	14.0	1.80	16.9	2.15	20.1	2.50	23.4	2.75	25.7	3.00	28.1	....	....	....	....	....	....	....	....	....	....	....	....	34.7	4.0	1.0	3.0	1.50	9.4	9.37	1.00
27	1.5	1.50	15.2	1.80	18.2	2.20	22.2	2.50	25.8	2.80	28.3	....	....	....	....	....	....	....	....	....	....	....	....	....	....	37.5	4.5	1.0	3.0	1.50	9.9	10.12	1.02
28	1.5	1.55	16.8	1.80	19.6	2.25	24.4	2.55	27.7	2.80	30.4	....	....	....	....	....	....	....	....	....	....	....	....	....	....	40.3	5.0	1.0	3.0	1.50	10.4	10.87	1.05
29	1.8	1.55	18.0	1.85	21.5	2.25	26.1	2.60	30.2	2.90	33.7	....	....	....	....	....	....	....	....	....	....	....	....	....	....	54.7	5.5	1.5	4.0	1.50	10.9	11.62	1.07
30	1.7	1.60	19.8	1.85	22.9	2.25	27.8	2.60	32.2	2.95	36.5	....	....	....	....	....	....	....	....	....	....	....	....	....	....	53.8	6.0	1.5	4.0	1.50	11.4	12.37	1.08
31	1.7	1.60	21.0	1.90	24.9	2.30	30.2	2.65	34.8	3.00	39.4	....	....	....	....	....	....	....	....	....	....	....	....	....	....	56.9	6.5	1.5	4.0	1.50	11.9	13.12	1.10
32	1.7	1.65	22.9	1.90	26.4	2.30	31.9	2.65	36.8	3.00	41.6	....	....	....	....	....	....	....	....	....	....	....	....	....	....	60.1	7.0	1.5	4.0	1.50	12.4	13.87	1.12
33	1.7	1.65	24.1	1.90	27.8	2.35	34.4	2.70	39.5	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	63.3	7.5	1.5	4.0	1.50	12.9	14.62	1.13
34	1.7	1.65	25.4	1.95	30.0	2.40	36.9	2.70	41.5	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	66.4	8.0	1.5	4.0	1.50	13.4	15.37	1.15
35	1.6	1.70	27.4	1.95	31.4	2.40	38.7	2.75	44.4	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	64.6	8.5	1.5	4.0	1.50	13.9	16.12	1.16

to select a section which will meet the requirements of *n, s,* and *v,* and the quantities in excavation and embankment will be given in the diagram of the nearest corresponding section.

Estimates, prepared from these diagrams, using the center cuts and transverse ground slopes, from the final profile notes, meet every requirement of an economic location. This estimate will not vary more than 5% from the actual quantities, as determined from the cross-section notes. In making up preliminary estimates from preliminary lines, these diagrams are extremely useful.

Table 1 gives the standard sections having capacities ranging from 1.0 to 90 sec-ft. The different sections were computed on grades giving velocities of from 1.0 to 3.0 ft. per sec. The section having the required capacity and grade can be selected and varied as desired. In covering any particular tract of land, that grade will be selected which corresponds best with the general slope of the country. A lateral of a given capacity can be located on a grade which will give any velocity required between the limits of 1.0 and 3.0 ft. per sec.

INFORMATION FURNISHED TO LOCATION PARTIES.

The information furnished to location parties consists of diagrams showing the yardage in excavation and the yardage in embankment, plus 10% for the various slopes to be encountered. From these diagrams a table of economic center cuts for the given section and transverse slopes can be prepared.

Estimates are also furnished showing the comparative cost of earth (loose and solid rock classifications); siphons under different heads; the cost per linear foot of standard flumes; the cost per linear foot of trestles of different heights; and the cost of different classes of tunnels.

The locating engineer designs and selects the section best fitted for construction through the country in which he is locating. The grade of the section having the desired water area may be changed to give the required velocity, if the material through which the location is to be made warrants a velocity other than 2.5 ft. per sec.

ORGANIZATION.

The organization of a locating party through uniform open countries consists of one locating engineer, one transitman, one levelman, one rodman, two chainmen, two stakemen, and a field draftsman.

Method of Location.

Level Party.—The level party, consisting of one levelman, one rodman, and one stakeman, precedes the location party. The rodman carries the stationing by pacing, following the grade contour as nearly as possible. At each station, or at closer intervals, depending on the irregularity of the country, the rodman gives two readings on the ground, 50 ft. apart, at right angles to the line of the proposed canal. These two readings give the transverse slope of the ground. The levelman then sets the rodman at a point, the elevation of which will give the desired economic center cut for that particular ground slope. The level party proceeds in this manner, setting the lath, flagged with white, not more than 100 ft. apart. These preliminary levels are carried very carefully, and, at this time, construction bench-marks are established, which are adhered to in running the final profile, in cross-sectioning, and in staking out structures.

At points where it is evident that a saving in distance and material is possible, by cutting through ridges or fills across gulches, the levelman runs a profile line on the cut-off, in addition to his contour line. From his section diagram comparative estimates of the two lines are made. In case the shorter line proves more economical, a row of red flags (red meaning off grade) is set on the economical location. Both lines are left in, and the estimate on each line is marked on its first flag.

The preliminary level line is run not more than ½ or ¾ mile ahead of the location party, on account of the difference in stations between the rodman's pacing and the measurement by the location party. This difference might be enough to affect the economic cuts due to the allowance in grade made by the levelman.

It has been found that the level party, in addition to setting the preliminary lath ahead of the transit party, is also able to take the final profile of the located line as it is run in.

Transit Party.—The transit party, in charge of the locating engineer, proceeds as follows: Being ahead of the transit party, the locating engineer picks out a tangent which will fit the flags established by the levelman. It is his endeavor, not to follow exactly the contour as shown by the levelman, but to lay a line which balances the yardage in excavation and embankment within the limits of economic haul. Having established such a tangent, the chainmen proceed along it, setting the stakes not more than 50 ft. apart. The locating engineer proceeds ahead to the point of intersection of the next curve necessary. As soon as the chainmen have set the stakes to within the distance estimated as the semi-tangent for the next curve, a P. C. is put in and the transitman is called up. The chainmen then measure the semi-tangent to the point of intersection, as established by the locating engineer. From this P. I. they chain the same distance along the other tangent of this curve, being lined in on the tangent by the locating engineer. This will give the approximate P. T. of the curve required. The transitman reads the angle from P. C. to P. T. and calculates the degree and length of curve to swing into the next tangent. The chainmen then proceed setting stakes on this curve and establish a hub with a tack at the P. T.

The field draftsman plots the alignment notes and section line ties, and makes the right-of-way map. He also prepares and finishes all profiles and estimates of quantities, including the quantity and direction of hauled material, keeping his work up as fast as the notes are turned in from the field. No estimate is placed on the profile until it is approved by the locating engineer. Any piece of location which does not balance up well in excavation and embankment, within the limits of economic haul, after the estimate on it has been prepared, is relocated.

In country where shale or rock comes close to the surface, a testing party is put on. In cases where the rock is so close to the surface that the economic cut would necessitate the excavation of some rock, the location is made so that there will be a minimum of rock excavation, it being cheaper to borrow the material for embankments than to make the rock excavation.

At points where it is necessary to have structures, such as drops, culverts, siphons, and highway or railway bridges, the locating engineer should choose the most economical location under the circumstances. He also draws detailed sketches in his notebook of the kind of structure best fitted for that location. In addition, topography is taken, showing accurately the lay of the surrounding country within the possible limits of changes in location.

Profile.—The level party takes the final profile, showing all the breaks in the ground, also the slope of the ground at right angles to the located line. The final profile and alignment notes are turned over to the field draftsman, and the notes and estimates of quantities are worked up.

Curvature.—The maximum curvatures allowed for canals of different sizes in earth are as follows: For canals with a carrying capacity of less than 400 sec-ft. the minimum radius permissible is six times the bottom width; for canals carrying from 900 to 400 sec-ft. the minimum radius is ten times the bottom width; and for capacities from 900 to 1 500 sec-ft. the minimum radius is twelve times the bottom width.

Curves of moderately long radius are not detrimental in the operation of any canal, and they should be used as far as possible to lighten the expense of construction. In locating around sharp rocky points, where the radius of curvature used is less than the allowable, the water slopes of the canal must be paved or rip-rapped for an adequate distance, in order to preclude the possibility of erosion.

In open country, where there is no timber to contend with, location by the above method costs from $45 to $65 per mile. This covers engineering salaries and expenses.

When the location on any particular canal has been finished and the estimates and profiles have been worked up, the data are sufficient to let the contracts. Until the line is cross-sectioned and the final quantities are worked up, the contractors are paid for work completed from the location quantities. The difference between the two estimates is balanced when the final measurements are made.

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PAPERS AND DISCUSSIONS

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PIONEER RAILWAY DEVELOPMENT IN THE UNITED STATES.*

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The First Chartered Railway.—Railway development proper began in England. In 1801—in the very beginning of the 19th century, the century which was to witness the most wonderful material achievements of the human race—the first chartered line of rails was laid for a short horse-car line from Wandsworth to Croydon, in the suburbs of London.† Lines of a similar character were constructed almost every year thereafter.

An Important Discovery.—In 1813 a discovery was made which led to the adoption of steam as a propelling power, instead of horses or stationary engines. It was discovered that cars could be propelled along a line of rails by the adhesion of a round smooth wheel to the head of a smooth rail. When Blackett made the experiment, however, he did not revolve his wheel by steam power.

"Six men were placed upon a frame, which was fitted up with a windlass attached by gearing to the several wheels. When the men worked the windlass, the adhesion was found sufficient to enable them to propel the machine without slipping."‡

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* This paper will not be presented at any meeting, but written communications on the subject are invited for publication with it in *Transactions.*

† Hadley's "Railroad Transportation," p. 9.

‡ Brown's "History of the First Locomotives in America." New York, 1871, p. 45.

The First Railroader.—George Stephenson, who was born on June 9th, 1781, in a colliery village on the north bank of the Tyne, became the forerunner and prototype of the modern resourceful and self-reliant railroader. In his childhood, wagons loaded with coal were pulled by horses over the tramway which passed his home. In his boyhood he worked in and about the coal mines, and became familiar with steam engines as they were used at that time, for pumping and hoisting in mines. It is said that at seventeen he was engineer of a pumping engine, with his own father as fireman under him. Stephenson constructed his first locomotive in 1814, and his second during the next year. He made many improvements in his successive locomotives. In 1822 the tramways leading to and about the Hatton Colliery, in Durham, had been converted into a locomotive railroad, and Stephenson was Chief Engineer. Concerning the day when the use of the steam locomotive was inaugurated, a writer says:

"Five of Mr. Stephenson's engines were upon the road that day, each engine drawing after it seventeen wagons loaded, averaging sixty-four tons, at the rate of four miles an hour."*

Railways or tramways propelled by horses had now been in operation many years in the transportation of coal, ores, and quarry products. As early as 1800 the use of horse tramways for purposes of general traffic between cities had been advocated by a Mr. Thomas, who brought the subject to the attention of the Literary and Philosophical Society of Newcastle. In 1820 Thomas Gray advocated the use of locomotives instead of horses as a means of propulsion on tramways, and published pamphlets and articles on the subject. He also advocated the building of the Liverpool and Manchester Railroad and many similar constructions. While Gray was getting public sentiment ready for the use of locomotives in general traffic, Stephenson was perfecting his locomotives, and learning to build the roads that were needed. The opening of the tramways of the Hatton Colliery as a steam-operated railroad, on November 18th, 1822, was attended by great crowds who came to witness the performance of the engines.

The Stockton and Darlington Railway.—At about this time Stephenson became Chief Engineer of the Stockton and Darlington Railway, a road about to be built for the purpose of tramming coal.

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* Brown's "History of the First Locomotives in America," p. 55.

The surveys had already been made when Stephenson was engaged, at £300 a year. His influence was not sufficient at this time to persuade the managers of this enterprise to lay out the road so as to have it operated by steam power, although they had been in person to see his locomotives working at Killingworth, where they had then been used successfully for ten years; but he succeeded in having certain changes made, and three locomotives ordered, so that he could at least compete against horses and stationary engines for the form of power to be used. The opening of the Stockton and Darlington line on September 27th, 1825, is thus described by Smiles:

> "At the foot of the incline a locomotive was in readiness to receive them, Mr. Stephenson himself driving the engine. The train consisted of six wagons loaded with coals and flour; after these was the passenger coach, filled with the directors and their friends, and then twenty-one wagons fitted up with temporary seats for passengers; and lastly came six wagon-loads of coals, making in all a train of thirty-eight vehicles. The local chronicler of the day went almost out of breath in describing the extraordinary event: 'The signal being given,' he says, 'the engine started off with this immense train of carriages; and such was its velocity, that in some parts the speed was frequently 12 miles an hour!' By the time the train reached Stockton there were about 600 persons in the train or hanging on to the wagons, which must have gone at a safe and steady pace of from four to six miles an hour from Darlington."*

The First Locomotive Works.—A little more than a year before this, Stephenson had persuaded the chief projector of the Stockton and Darlington Railroad to become his partner in the organization of a factory at Newcastle for the construction of locomotives.

The Traffic on the Stockton and Darlington Railway.—The working of the Stockton and Darlington Railroad was a surprise to its most sanguine projectors. The line was constructed without any view whatever to passenger traffic, and with little expectation of doing anything more than to supply the local demand for coal at the stations along the route; but the existence and operation of the road soon did what has been done in thousands of instances since then—it created a traffic which was non-existent before. The first passenger coach was run on this road; it had been built at Stephenson's factory at Newcastle. It was propelled by horses, and its operation at first was leased to private parties. On this road it was first demonstrated that a railway cannot be operated like a highway, with the patrons of the road owning the vehicles and regulating their movements. The gauge of the tracks of this road was fixed so as to accommodate the greatest number of trucks then used on the highways, most of which were 4 ft. 8½ in. from in to in of the wheels.

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* Smiles' "Lives of the Engineers," Vol. V, 1874, p. 137 (or Vol. III, 1868, p. 168).

The Liverpool and Manchester Line.—The success of the Stockton and Darlington road, and of the locomotives that Stephenson built and put upon it, led the way to the construction of the more famous Liverpool and Manchester Railway, and to the use of steam power thereon. It is well to note that the Stockton and Darlington Railway was built because a canal was not feasible or was too expensive; but the Liverpool and Manchester Railway was projected because the canals between the two towns could not take care of the existing traffic. The Public Declaration in regard to this railroad, drawn up in Liverpool in 1824, and signed by 150 or more of the principal merchants, explained that they considered "the present establishment for the transport of goods inadequate, and that a new line of conveyance has become absolutely necessary to conduct the increasing trade of the country with speed, certainty and economy."*

Motive Power for the Liverpool and Manchester Line.—Even in 1829, when the construction of the Liverpool and Manchester Railway was nearing completion, the form of motive power to be used was a mooted question. Several impractical methods were proposed, but the directors were halting between horse-power and stationary engines. The locomotive, on account of its supposed dangers and inconvenience to the public, had few adherents. It was claimed that the gases exhaled from it were so poisonous that birds flying across the track in its wake fell down dead, and that all vegetation would be killed for great distances on each side of the road.

In this year was conceded the Newcastle and Carlisle Railway Act, which definitely excluded locomotives, and fixed upon horse-power as the traction to be used. Even while this question was being fomented, Stephenson had some of his locomotives at work hauling at the excavations for the construction of the road. The contemplation of the immense traffic that would come to the road finally excluded the consideration of horse-power, and, in the spring of 1829, a committee of two eminent engineers was appointed to report on the best form of power to be used on the new road. These engineers concurred in the opinion that the first cost or interest charge of the plant to operate the road would be greater if stationary engines were used, while the working expenses would be greater if locomotives were used. On the whole, stationary engines would be cheaper in operation. The cost per ton-mile of traffic would be 0.28d if locomotives were used, and 0.21d with stationary engines. In the report of Mr. J. Walker, one of the two engineers referred to, the conclusions arrived at are thus summarized:

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* Smiles' "Lives of the Engineers: The Locomotive." John Murray, London. 1874. p. 154.

> "Our opinion is that if it be resolved to make the Liverpool and Manchester Railway complete at once * * * the stationary reciprocating system is the best; but that if the power was to be proportioned to the demand then locomotives would be preferable."

In their plan of working the road, the 32 miles were to be cut up into 21 sections, with fixed engines to propel the trains. The final offer of £500 as a prize by the directors for a locomotive which should best fulfill certain conditions, and the winning of the prize by Stephenson's *Rocket* in October, 1829, is now familiar history.

Passenger Traffic.—It is interesting to note that, even with the example of the Stockton and Darlington Railway before them—considerable passenger traffic having been developed where none existed before—the management of the Liverpool and Manchester line made little or no provision in their outlay for passenger traffic.[*] The road was constructed entirely with a view of taking care of heavy traffic, such as coal, cotton, timber, and merchandise, whereas the receipts from passenger traffic in this densely settled locality soon outgrew those from freight. The massiveness of the construction in this early line was somewhat startling, and the cost would be considered prohibitive, even at this day, on all but the most important lines in America. The road was more than four years in active construction, and was double-tracked from the beginning. There was a tunnel 1½ miles long at Liverpool, and a 2-mile cutting, for the most part in solid rock, and 80 ft. deep at some points. The cost of the construction and equipment amounted to more than $130 000 per mile. The rail was light, weighing 35 lb. per yd., and, for the most part, was of forged iron. Each rail was 15 ft. long, and was supported every 3 ft. on stone blocks. The construction of the Manchester and Liverpool line and the successful use of Stephenson's locomotives thereon were such wonderful achievements, and became so well known, that all opposition to the new mode of locomotion and of moving traffic was broken down, and the English people entered upon the first era of railway construction.

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[*] In a description by an early passenger over the road occurs the following: "The first class of train is the most fashionable, but the second or third are the most amusing. I travelled one day from Liverpool to Manchester in the lumber train. Many of the carriages were occupied by the swinish multitude and others by a multitude of swine." ("Railroads: Their Origin and Problems," by Charles Francis Adams, Jr., G. P. Putnam's Sons, New York, 1878, p. 35.)

Railway Beginnings in America.—Other countries were watching these interesting developments in England, and none with more vigilance than the United States.

In December, 1824, there was organized the "Pennsylvania Society for the Promotion of Internal Improvements in the Commonwealth." Early in 1825 this Society sent William Strickland, an architect, to Europe, to collect information in regard to canals, roads, railways, steam engines, and the industrial arts. The result of Strickland's researches was scant, as far as concerned information on railways; but, from the elaborately prepared instructions to him as to the objects to be obtained by his visit, some insight can be gained as to the attitude of mind of the more intelligent Americans in regard to the development of transportation matters.

> "'It is not a knowledge of abstract principles, nor an indefinite and general account of their application to the great works of Europe, we desire to possess through your labors. * * * What we earnestly wish to obtain, is the means of executing all those works in the best manner, and with the greatest economy and certainty; and for these purposes you will procure and exhibit in your reports, all that will enable those who shall undertake the formation of canals, railways, and roads, * * * to perform the work. * * * To use a term which is familiar to you as an architect, we desire to obtain working plans of the best constructed canals, and their locks and inclined planes; of railways, and all means of using them to advantage; of roads and of the mode of their formation and preservation; * * *
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> "'*Canals and Railways* present the most important of all subjects for your attention. Upon every matter connected with both you will be expected to be well informed; and if you shall have to decide between them you must be able to furnish the facts and circumstances by which the decision shall be produced. Much excitement prevails in this state upon the question whether railways are superior to canals, * * *.'"*

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* "Development of Transportation Systems in the United States." J. L. Ringwalt. Philadelphia, 1888, p. 70.

The United Kingdom was covered by a network of good highways and canals. Railroads were necessary only as a means of further development and because traffic had overgrown the other means of transportation. In 1830 the United States had few canals and few highways. There was great dearth of the means of intercommunication. In England the introduction of the railway was on a grand scale befitting the establishment of a means of intercommunication which was to be the beginning of another era of civilization.[*] The constructions were massive and the outlay great. The opening of the Liverpool and Manchester line was an event which attracted the presence of persons famed in history.

In America everything connected with the early railways was meager and poor. Had it been necessary to begin on the magnificent scale on which the Liverpool line was laid out, the development of America must have waited; but railways made a beginning in America almost as soon as in England. There is some reason to believe that the first railroad ever constructed with a view of using steam as a motive power was built in the United States.

The First Tramway in America.—In 1826 a tramway some 3 miles long was built at Quincy, Mass., for conveying stone for the Bunker Hill Monument. It was operated as a tramway until 1871, using only horses as a motive power. Its cost was $34 000. Instead of cross-ties, it had granite blocks laid transverse to the line every 8 ft. The rails were of pine, 12 in. deep. The top of the pine rail was covered with a strip of oak, and this in turn with flat strips of iron. The gauge was 5 ft., and the grade was descending from the quarry to the Neponset River. On it two horses could draw a load of 40 tons. This is frequently mentioned as the first American railroad; but it was not a railroad at all until 1871, when it was bought up by the Old Colony Railroad. The old structure was demolished and a modern road was built on the right of way.[†]

The Mauch Chunk Tram.—The next American tramway seems to have been built in 1827 from Mauch Chunk, Pa., to the Lehigh River, a distance of 9 miles. It was built to convey coal from the mines to the river boats. The descent was very great, and the cars went down by gravity when loaded and were drawn up to the mines by mules when empty, though, according to some accounts, the cars were pulled up hill by a stationary engine.[*] The construction of the track was similar to that of the Quincy tram, except that, for cross-ties, wooden sleepers were used.

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[*] G. S. Morison's "The New Epoch as Developed by the Manufacture of Power," Boston, 1903.

[†] Adams' "Railroads: Their Origin and Problems," p. 38.

The First American Railways.—The South Carolina Railroad was opened for traffic on January 15th, 1830. It was early projected to unite Charleston Harbor and the mouth of the Oriskany. The road was constructed with a view of using the locomotive. A queer-looking machine, named the *Best Friend,* was built at the West Point Foundry Works, in New York, in the summer of 1830 for use as a locomotive on this road. It was certainly no infringement on any patent of Stephenson's. The boiler was vertical, and of the porter-bottle shape. The furnace at the bottom was surrounded by water and some additional heating surface was supplied by projections or "teats" running inside from the sides and top. As originally constructed, it had double crank axles, wooden wheels, and iron tires. This engine arrived in Charleston in October, 1830, and made several trial trips before the celebration of the anniversary of the opening of the road, in January, 1831. It was said to have reached speeds of from 16 to 21 miles an hour with 40 or 50 passengers in 4 or 5 cars, and from 30 to 35 miles an hour without cars. One hundred and fifty or more of the stockholders and their guests, with bands playing, with a field piece and a detachment of United States troops, paraded over the road and "great hilarity and good humor prevailed throughout the day." Not long after this celebration—in the following June—the *Best Friend* came to grief. The negro fireman, annoyed by the popping off of the safety valve, held it down and both the fireman and the *Best Friend* were incapacitated for further service.[†] In 1834 this road was 135 miles in length, running from Charleston to Hamburg, on the Savannah River, opposite Augusta, Ga. The grades did not exceed 30 ft. per mile. The "plan of the road is unusually straight and the curves have large radii." The track was composed of flat iron bars attached to longitudinal 6 by 10-in. stringers. Timber pile trestles were used in lieu of embankments to such an extent that "the railway resembles a continuous and prolonged bridge."* The exposed part of the timber was "protected by a coating of heated tar and oil." The cost of the line was less than $13 000 per mile, including equipment. It was sold before 1840 to another company for $17 500 per mile. During November, 1839, it earned $65 000, which was "nearly 50 per cent. more than was taken in any previous month."

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[*] Poor's "Manual," 1869-70, p. xxii.

[†] In May, 1831, an accident occurred in the operation of the Charleston and Hamburg which necessitated an explanation from the Chief Engineer to the President of the Company:

"CHARLESTON, May 14, 1831.

To ELIAS HORRY, Esq., President.—

"Sir:—I hasten to communicate the causes which produced the accident of yesterday afternoon. It originated in the wild derangement of the tongue, which guides the wheel through the turnout, by some ill-disposed person, and was rendered injurious to the car by the imprudent speed allowed by those who had the management of the engine—the tongue having been nailed to its proper position, but was made loose by removing the fastening, and was probably shaken from its place by the speed with which the engine and one car had preceded the one injured. Directions have been given to pass the turnout at moderate speed, and the attention of the person in charge to be constantly kept on the road in advance of the engine.

"Respectfully your obedient servant,
"HORATIO ALLEN."

In 1829 three locomotives were secured from Stephenson's works at Newcastle, for the Delaware and Hudson Canal and Railroad Company, and on that company's road, in August, 1829, and probably on the 8th day of the month, at Honesdale, Pa., the first locomotive driving wheel was turned by steam power in America. These three engines were failures, however, in two ways: They did not have Stephenson's last improvement of the multitubular boiler, and they were too heavy for use on the tracks on which they were placed.

The Baltimore and Ohio.—The pioneer American road for purposes of general traffic was the Baltimore and Ohio, which was chartered on February 28th, 1827, though construction did not begin until 1828. Even then it was slow in building, and only 13 miles were ready for traffic in 1830. However, 135 miles had been built in 1835. The road was organized to try to regain the Western traffic, which had been deflected from the Cumberland road by the opening of the Erie Canal. Eminent French engineers had been employed to survey a canal across the Alleghanies to connect with the waters of the Western rivers. The expense was entirely beyond the resources of the people. The railway was organized simply because a canal could not be had. At the outset it was expected that horses would be the motive power. A car to be propelled by sails was put on the road, and worked very well—when the wind blew strong and from the right quarter.

It was on this road, on August 28th, 1830, that a trial of speed between Peter Cooper's locomotive, *Tom Thumb,* with Peter Cooper himself as engineer, and a horse, each drawing equal loads, resulted in a victory for the animal and not for the machine. The *Tom Thumb* weighed only 1 ton, and the diameter of its cylinder was 3½ in. Stephenson's success in his great contest was due to two great improvements in *The Rocket:* one was the waste steam blast through the smoke-stack, to increase the draft, and the other was the multitubular boiler, to increase the heating surface. Cooper had built the *Tom Thumb* with the latter improvement, but not the former. Not being able to secure the usual tubes, Cooper had used gun barrels in his boiler. The steaming power of the *Tom Thumb* was dependent upon a special device to increase the draft, which device failed on the occasion of the race mentioned. Peter Cooper, however, built the *Tom Thumb* only as a working model, to demonstrate his belief in the adaptability of the locomotive to the sharp curves in the tracks of the railways of this country which were made necessary by economy. That the locomotive could be adapted to as sharp curves as were used on American roads was denied by many of the most eminent European engineers. The European roads were straight, or had very gentle curves; but Cooper ran the *Tom Thumb,* without any appreciable decrease of speed, around curves of less than 300 ft. radius.* The performance of this engine, however, on the tracks of the Baltimore and Ohio, resulted in a much greater benefit than in making this demonstration.†

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* "A Description of the Canals and Rail Roads of the United States," by H. S. Tanner, New York, 1840.

The construction of this road, from Baltimore to Ellicott's Mills, was very expensive, one excavation near Baltimore being 70 ft. deep and costing $122 000. Between Baltimore and the Potomac at the

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* John H. B. Latrobe's Lecture before the Maryland Institute, March 23d, 1868.

† Ross Winans, who had witnessed the tests of the *Rocket* in England, also rode behind Cooper's engine on the Baltimore and Ohio. From a long letter to the President of the Company, dated August 28th, 1830, the following abstracts are taken:

"Mr. Cooper's engine has to-day moved a gross weight of four and a half tons from the depot to Ellicott's Mills and back in the space of two hours and ten minutes, which, as you are aware, the distance being twenty-six miles, gives an average speed of twelve miles to the hour. As the engine returned with its load to the same point whence it started, the acclivities and declivities of the road were, of course, balanced;

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"To-day's experiments must, I think, establish, beyond a doubt, the practicability of using locomotive steam-power on the Baltimore and Ohio Railroad for the conveyance of passengers and goods at such speed and with such safety (when compared with other modes) as will be perfectly satisfactory to all parties concerned, and with such economy as must be highly flattering to the interests of the company. It has been doubted by many whether the unavoidable numerous short curves on the line of your road and the inclined planes would not render the use of locomotive-power impracticable; but the velocity with which we have been propelled to-day by steam-power round some of the shortest curves (to wit, from fifteen to eighteen miles per hour) without the slightest appearance of danger, and with very little, if any, increased resistance, as there was no appreciable falling off in the rate of speed, and the slight diminution in speed in passing up the inclined planes, some of which were nearly twenty feet to the mile, must, I think, put an end to such doubts, and at once show the capability of the Baltimore and Ohio Railroad to do much more than was at first anticipated or promised by its projectors and supporters." (Brown's "History of the First Locomotives in America," pp. 118 and 119.)

Point of Rocks, 68 miles out, there were thirty-one stone viaducts. In 1840 the capital of the road was $5 000 000, and the line had been built to Harper's Ferry, 80.5 miles from Baltimore. It was also located to the Ohio River at Wheeling, but this construction was not completed until 1852, at which time it was the longest railroad in the world. The Washington Branch of this road was opened for traffic on August 25th, 1835. The first trains were spoken of as "a brigade of cars." The *Baltimore American* of May 24th, 1830, said: "A brigade of cars will run three times a day each way from Baltimore to Ellicott's Mills—passage 25 cents."[*]

The Early Passenger Cars.—The early passenger cars on the Baltimore and Ohio Railroad were horse cars "like a market-car on railroad-wheels. Then came cars resembling the old-fashioned stage-coach, with the same springs and leather braces. * * * For a long time the cars were gaudily painted. * * *"[†] Ross Winans, who also was the real inventor of the "friction wheel" and of the "outside bearing" on which principle the world's rolling stock is now constructed, introduced on this road, prior to 1833, the first eight-wheeled car ever built for passenger service. It was named the *Columbus,* and had four-wheeled trucks at each end.

Steel Springs.—Another great improvement, made in the early days of the Baltimore and Ohio, was the introduction of steel springs under both locomotives and cars, to relieve the jolting. This experiment was first tried on the locomotive *York,* in September, 1832, and was found to work so well that springs were added to the cars as well. At the great opening of the Liverpool and Manchester, the distinguished visitors must have had a very rough ride, unless Stephenson had put his road in uncommonly good line and surface beforehand; for the early trains went pounding and thundering over the track at a fearful rate, before the roughness was relieved by steel springs. An early director of the Baltimore and Ohio proposed to relieve the jolting by putting a thin sheet of lead between the iron rail of the track and the supporting stone stringers, to act as a cushion. The Baltimore and Ohio was the pioneer railway line of America in other ways than that of priority. The early results attained by this road are thus described:

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[*] The description of the track of the Baltimore and Ohio road given in Tanner's "Canals and Railroads," p. 150, is instructive:

"The superstructure is various: it consists of stone sills, stone blocks and wooden sleepers, on different parts of the line. Forty miles of single track are composed of granite sills, 8 inches thick, 15 wide, and of various lengths: these are laid in trenches, filled with broken stone. Six miles of single track are composed of stone blocks and wooden string-pieces, 6 inches square. The blocks are 4 feet apart, from centre to centre. The line hence to the Potomac, rests on wooden sleepers, four feet apart and imbedded in broken stone. The sleepers are hewn out in the centre to make room for the horse-path. The iron bars are 15 feet in length (pierced by 11 oblong holes) 2½ inches wide, $\frac{5}{8}$ inch thick, and bevelled at the ends."

[†] Brown's "History of the First Locomotives in America," p. 101.

"In the construction of the road from Baltimore to the Point of Rocks, every mode hitherto suggested by science or experience had been tested, and thus the work must be regarded as having the honor of solving most of the problems which presented themselves in this early period of railroads in this country. The granite, and the iron rail; the wood and iron, on stone blocks; the wood and iron on wooden sleepers, supported by broken stone; the same supported by longitudinal ground-sills in place of broken stones; the log-rail, formed of trunks of trees, worked to a surface on one side to receive the iron, and supported by wooden sleepers; and the wrought-iron rails of the English mode—had all been laid down, and as early as 1832 formed different portions of the work. * * * Their road and workshops have been a lecture-room to thousands who are now practising and improving upon their hard-earned experience."*

Early New York Roads.—The initial trip of the locomotive in New York State was over the Mohawk and Hudson Railroad from Albany to Schenectady on August 9th, 1831. The sketch of this first train in New York State, drawn by the *DeWitt Clinton,* and made up of stage-coach cars placed upon trucks, is now familiar to every schoolboy. The *Albany Argus,* of September 26th, 1831, gives an interesting account of a trip of certain officials over this road. Concerning the dining in Schenectady after a trip up from Albany, the account says:

"Among the toasts offered was one which has been verified to the letter, viz.: 'The Buffalo Railroad—may we soon breakfast in Utica, dine in Rochester, and sup with our friends on Lake Erie!' "†

If one were to ride on the fastest trains on the New York Central to-day, he would find an opportunity to eat those three meals inside of four hours. Tanner's description of the track of the Mohawk and Hudson, written about 1840, reads as follows:

"The cross sleepers are of wood, 7 inches in diameter, and 8 feet in length. The iron plate is a bar, $\frac{9}{16}$ by $2\frac{1}{2}$ inches, with the upper curves rounded to $1\frac{7}{8}$ inches width. The stone blocks are laid three feet apart from centre to centre, on broken stone, and on these the timber rails are placed. The width between the rails is 4 feet 9 inches. The company was chartered in 1826, with a capital of $600 000, or about $38 000 per mile; and the work was commenced in 1830; double track completed in 1833."*

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* Brown's "History of the First Locomotives in America," p. 140.

† *Ibid*, p. 186.

The line from Schenectady to Utica was not completed until about 1836, and continuous connection by rail from New York to Buffalo was not obtained before 1842. The Erie Canal had then been opened 17 years.

Early Pennsylvania Roads.—By the end of 1835 Pennsylvania was well in the lead of any other State in railway construction, 265 miles being open for traffic. The Columbia Railroad (now a part of the Pennsylvania) from Philadelphia to the Susquehanna River, was opened in 1834. By the end of 1837 a chain of canals and railroads joined New York, Philadelphia, Baltimore, Wilmington, and Pittsburg, thus bringing the interior of the country along the Ohio and Mississippi Rivers into closer commercial relation with the Atlantic seaboard.

Early Massachusetts Roads.—The chartering of railroads began in Massachusetts in 1830, and by 1835 three lines leading out of Boston, to Providence, Lowell, and Worcester, were constructed. These were all opened for traffic within four weeks of each other, in the summer of 1835. It is interesting to note that in America many of the early engineers learned to build cheap roads. Oftentimes, when English methods were adopted, failure resulted. Charles Francis Adams, Jr., former President of the Union Pacific, says:

> "It is, indeed, matter of curious observation that almost uniformly those early railroad builders made grave blunders, whenever they tried to do their work peculiarly well. * * * The Lowell road, for instance, was too well built in many respects. On a portion of its track the stone blocks, into which the oaken plugs to spike the rails to were inserted, were laid on a foundation of continuous, parallel, dry, stone walls running in trenches under each line of rails, and from two and a half to four feet deep and a foot and a half wide, * * * and to-day the sides of the road-bed are liberally ornamented with those useless stone sleepers, the eternal life of which was once looked forward to with confident pride."†

The Worcester line was saved from such blunders by the good judgment of its constructing engineer, who, although he had been sent to

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* Tanner's "Canals and Railroads of the United States," p. 77.

† Adams' "Railroads: Their Origin and Problems," pp. 74 and 75.

England to study English methods of construction, saw that the objection to the use of wood in England, on account of scarcity and cost, did not prevail in the United States. When the Erie Canal was completed, and the commerce of the West flowed into New York, Boston was eager for a similar connection to the West. As early as 1826, the year after the Erie Canal had opened, the Legislature of Massachusetts had appointed a commission to survey a route for a canal from tide-water at Boston to the Connecticut, and thence to the Hudson. A canal running across the Berkshire Hills was not a particularly feasible engineering undertaking; but the canal was projected on paper, and it was to have a 4-mile tunnel on the site now occupied by the Hoosac Railway Tunnel.* The project lay dormant, however.

In 1829 the *Boston Daily Advertiser* gave full accounts of the performance of the *Rocket* and of the construction of the English railway lines. It also gave full accounts of the spectacular opening of the Liverpool and Manchester line. The charters of the three roads previously mentioned were granted by the Legislature, as a result of the success of the English roads and locomotives.

The Western Railroad, as it was called, was begun in 1834, from Worcester west through Springfield to the western edge of the State, where it connected with another road which joined it to the Hudson. Through many financial troubles its construction was continued until its completion in 1841, when Boston was at last connected with the stream of Western traffic.

The First Era of Railway Construction.—To no other country could the advent of the railway in 1830 have meant what it did to the United States. The country's inhabitants were scattered along lines of water communication, along the coasts of the Gulf and of the Atlantic, along the shores of the Great Lakes, and along the navigable rivers and the canals. President Hadley says:

> "The system of internal water-routes is a thing of the present in more senses than one. When no longer used, its influence is still felt, because it has laid down the lines of the country's development."†

The riches of the great interior country, of the splendid forests of timber, of the fertile interior valleys, of the bounding prairies, and of the coal, iron, copper, gold, and silver fields, were largely known and perhaps wholly anticipated; but they were all unavailing for lack of highways of commerce. In Colonial times it took a week to go from Boston to New York by stage, a distance which the New Haven road hopes soon to cover by a 4-hour train. Between these points there was a tri-weekly mail service. President Hadley says, of the conditions of the country at a period immediately succeeding the Revolution:

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* Adams' "Railroads: Their Origin and Problems," p. 53.

† Arthur Twining Hadley's "Railroad Transportation." G. P. Putnam's Sons, 1886. p. 28.

> "Long-distance freight movement was absolutely impossible. The charge for hauling a cord of wood twenty miles was three dollars. For hauling a barrel of flour one hundred and fifty miles it was five dollars. Either of these charges was sufficient to double the price of the article and set a practical limit to its conveyance. Salt, which cost one cent a pound at the shore, would sometimes cost six cents a pound three hundred miles inland, the difference representing the bare cost of transportation. It was on these cheap articles of common use that the charge bore most heavily. It forced every community to live within itself."*

The use of turnpike roads, which were built to provide for through traffic, began in America in 1790. The system was pretty well developed in certain parts of New York, Pennsylvania, and Southern New England. Except in Kentucky and Tennessee, the turnpike system, south of the Ohio and the Potomac, never amounted to much. These roads were maintained by a system of tolls. National aid for turnpike roads began to be agitated in 1808. The plan of national development of the turnpike proposed three radiating lines from Washington, leading to Detroit, St. Louis, and New Orleans. It included a line of road along the coast from Maine to Georgia, and a line of roads and canals connecting the Mississippi and its tributaries with the cities of the Atlantic seaboard. Most of the agitation and legislation on the subject came to nothing. Almost the sole result of national aid to turnpikes was the Cumberland road, connecting Washington, Wheeling, Columbus, and Vandalia, on which the Government spent somewhat more than $4 000 000. The mania for turnpikes was succeeded by a mania for canals. The receipts from the Erie Canal nearly doubled in the period from 1826 to 1833. The canal rates were reduced about 40% in 1834, and the traffic of the Canal was increased so much under this encouragement that the receipts continued to increase; they exceeded the expenditures by $942 000 in 1833, and by $1 125 000 in

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* Hadley's "Railroad Transportation," p. 25.

1836. Thus the Canal lowered rates, but increased commerce, and made money. It brought commerce in such a stream to New York City that that city was forging ahead of all its competitors. At Utica, Syracuse, and Rochester, large cities were springing up along the course of the Canal. The increase of population in New York State from 1820 to 1840 was 1 056 000, while, in the same period, the increase was only 215 000 in Massachusetts, and 63 000 in Maryland. With such results before them, it was small wonder that Massachusetts contemplated building a canal across the Berkshire Hills; and Baltimore, across the Alleghanies. Canals, however, could not be constructed so as to accommodate the traffic of all parts of the country. While they were very successful in Pennsylvania and New York, and in a large part of the territory between the Lakes and the Ohio, those of Virginia and Indiana were not prosperous.

Two great internal lines of water transportation have exerted and retained a marked influence on the development of the United States, and only two: one running east and west through the Great Lakes and the Erie Canal, and one running north and south along the Mississippi and its tributaries. These routes continue to exercise a potent influence over commerce, even to this day, though at present the canals and rivers are all but deserted by the commerce of the country. The construction of canals was terminated somewhat abruptly in 1837 by the financial crisis, and, by the time the reaction set in and normal conditions returned, public opinion had decided that these systems of public works had not been beneficial, and that the interior commerce of the country was not to be carried on by water. By 1840 there had been constructed 2 800 miles of railway, and the United States may then be said to have been fairly launched on a period of railway construction, and to have been committed to the policy of developing the resources of the country by means of railways.

Conditions at the End of the First Decade of Railway Construction.—All railway construction had been in response to a well-defined need. The early railroads were built to connect points between which traffic already existed and was carried on by less convenient means. The country had not yet had enough experience with the results of improved means of intercommunication to justify railroad extension into new country into which the railway should bring the population from which its traffic was to be derived. The railway was something new, and its rules of operation and development were unknown. These could not be learned except in the school of experience. The only modes of interior transportation heretofore had been highways and canals. Ideas born of the operation of both turnpikes and canals were dominant in the development of the early railways. This was apparent in the use made of the railways, in the forms of construction adopted, and in the legislation affecting them. It required years of experience to prove that the railway was neither a turnpike nor a canal.

Even by the construction of roads to connect one locality with the next, however, something like systems of development were forming. Many of those engaged in railway building failed to see the trend of this development; but, that the country was looking for such a method is evident from the system on which the proposed national turnpikes were planned. Even at this early date, four separate chartered railway companies between Philadelphia and Baltimore had combined to form one.

By some a principal line of communication was thought to be forming between the crest of the Alleghanies and the Atlantic Coast, extending all the way from Portsmouth, N. H., to Pensacola, Fla. This was to become the channel along which the main stream of American traffic should flow. Other lines of communication were to intersect this at angles more or less acute, cutting through to the cities of the coast and going back into the interior of the country along the most available lines of least resistance. Among these secondary traffic routes were those from New York and Boston westward along the Hudson and Mohawk Valleys and the shores of the Lakes, from Philadelphia westward along the Susquehanna and the Ohio, from Baltimore westward along the Potomac and the Ohio, and from Richmond westward along the James, the Kanawha, and the Ohio. This great future traffic route would not cross the mountains, though it would cross the streams. Great canals could not cross the mountains, and it had not yet been shown that great railways could. Peter Cooper had demonstrated at the outset that the track need not be straight, but, before 1835, no one had shown that it need not be level—or nearly so. On these early railway lines the great ascents were overcome by inclined planes operated by stationary engines. The Stockton and Darlington Railway had such planes, and a stationary engine hauled the cars up on one side and lowered them on the other. The Liverpool and Manchester line avoided the planes, except at three points, by cutting through the elevations on a more expensive plan than American lines could adopt. The steepest grade used, except on the planes, was 4 ft. per mile. Consequently, in 1840, the railways in America were full of planes. The celebrated trip of the *De Witt Clinton* took place from the "top of the plane at Albany" to "the head of the inclined plane at Schenectady."* A part of Tanner's description of the Baltimore and Ohio reads as follows:†

> "First inclined plane, 41 miles from Baltimore, ascends 80 $\frac{375}{1000}$ feet in a distance of 2 150 feet. The second plane ascends 99 $\frac{605}{1000}$ feet in 3 000 feet. The summit, at Parr's Spring Ridge, is 813¼ feet above mid-tide. The line then descends by an inclined plane, 3 200 feet long, descending 159.63 feet, and another, 1 900 feet long, and descends 81.350 feet. All the planes are straight."

The most noted example of the use of these planes, however, was on the Portage Railroad, over the Alleghanies between Hollidaysburg and Johnstown, on the through-traffic route between Philadelphia and Pittsburg, over practically the present route of the Pennsylvania Railroad, which route was completed and opened for traffic in 1834. The distance from Hollidaysburg west to the summit was 10 miles, and 1 200 ft. vertical of the 1 400 ft. difference in elevation were overcome by five inclined planes interspersed with more level portions of road. The combined length of these planes was 13 500 ft. From the summit west to Johnstown the distance was 26.5 miles, and the difference of elevation was 1 170 ft. On the descent there were also five planes having a total length of 9 670 ft., on which the descent was 800 ft. The gradients on the lightest of these planes was 7 in 100, and on the heaviest, 9.8 in 100.‡

There was an inclined plane at the quarry on the Quincy tramway. During the construction of the Boston and Providence Railroad a party of gentlemen was taking a pleasure ride up this plane when the pulley broke and the car ran backward down the plane, throwing them out and killing one of them. Mr. Adams says that this incident illustrated "the value of fatal accidents as a dynamic force in railroad development."* This accident brought the inclined plane into disfavor, and the Boston and Providence excluded them, at great cost. Although other roads deplored their use, they did not know how to avoid them. In 1840 Charles L. Schlatter, Principal State Engineer of Pennsylvania, made his report to the Canal Commissioners of Pennsylvania on a survey for a continuous railway from Harrisburg to Pittsburg. In this report it was demonstrated for the first time that the Alleghany Mountains could be crossed without the use of inclined planes.

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* Brown's "History of the First Locomotives in America," pp. 176 and 180.

† Tanner's "Canals and Rail Roads," p. 149.

‡ Sipes' "The Pennsylvania Railroad." Philadelphia, 1875.

The value of Western connections was not underestimated. In 1840 Tanner wrote:

> "The immense effects which a connected system of improvements between the East and West, must produce in securing the trade of the latter to the Atlantic states and in cementing that bond of union upon which the safety of our institutions depends, would furnish, upon the proper occasion, a subject of interesting and profitable inquiry."

The early practical railroad men wasted no time in trying to develop systems of road parallel to the ocean front. At Richmond, Baltimore, Philadelphia, New York, Boston, and Albany, attention was concentrated on the construction of lines toward the West—toward the great interior of the country.

The cars and locomotives of 1830 were very light. Freight cars carried from 2 to 3 tons of freight, and weighed empty from 1 to 1.5 tons. In 1831, on the Baltimore and Ohio Railroad, it required a train of eight cars to transport 200 bbl. of flour, the loaded train weighing 28 tons. The chief engineer of the Baltimore and Ohio said in 1832:

> "In the year 1828 the power of the locomotive engine was no more than sufficient to propel itself up an ascent of 1 in 96 at the rate of 10 miles an hour, without dragging any load after it. In the course of two years after, however, such were the improvements made in this engine that it could draw up that ascent a train of cars weighing, with their freight, 17 tons, at 10 miles per hour. At the same time, it could draw on a level, at the same speed, $53\frac{4}{10}$ tons; at 15 miles per hour, 30 tons, and at 20 miles per hour, 15 tons."†

In 1831 the advertisement of the Baltimore and Ohio for American engines read:

> "The engine, when in operation, must not exceed three and one-half

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* Adams' "Railroads: Their Origin and Problems."

† Ringwalt's "Transportation Systems in the United States," p. 99.

tons' weight, and must, on a level road, be capable of drawing, day by day, fifteen tons, inclusive of the weight of the wagons."*

The first English locomotive, imported in 1826, weighed only 7 tons, and yet it had to be discarded because the track could not carry it. The strap-iron rail and wooden stringer track retarded the use of heavier locomotives, but trains rapidly increased in weight. The first annual report of the Erie road, in September, 1835, said:*

"The board of directors now have the gratification of announcing to the stockholders the following result, to wit: That loads of sixty tons gross (or, deducting the weight of the cars, forty tons net), may be drawn in a single train from the Hudson river to lake Erie, and at an average speed of from twelve to fourteen miles to the hour; * * *."

It was said in 1840 that an engine weighing 12 tons pulled a train of 470 tons gross weight behind the tender over a level or descending portion of the Reading road 54 miles in 5½ hours. On the return trip it pulled 182 tons behind the tender up a grade of 18.4 ft. per mile. In 1840 the Baldwin Locomotive Works had already constructed 137 locomotives for 39 different companies in 17 different States.

One of the most troublesome features in early railroading was the rate of wear of the imperfect iron rails used. The distinguished civil engineer, Charles Ellet, Jr., writing in the *Mechanics Magazine* (New York) in April, 1844, said that eight or ten of the railroads of the country had worn out the common ½-in. flat bar rail by carrying 150 000 net tons of freight over their lines. The Camden and Amboy wore out its 40-lb. "edge rail" with 400 000 net tons of traffic. In 9 years the rails of the Liverpool and Manchester line had to be entirely replaced four times. From 1825 to 1842 the net traffic on the Stockton and Darlington, which had been carried in light cars at speeds of 6 miles an hour, summed up 6 500 000 tons. Besides a great amount of patching, the rail of the track had then been entirely renewed six times. The London and Birmingham started in constructing its line with 50-lb. iron rail, and it was worn out before the road was completed. Ellet, in the article referred to, calculated that the cost of rail wear alone per ton-mile of net freight on the Reading road was 4.75 mills, a figure greater than that at which coarse freight can now be carried at a profit by probably all the larger railways of the country.

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* Ringwalt's "Transportation Systems in the United States," p. 99.

The telegraph service was not available for railway operation until about 1850. With no telegraph or telephone connection, with no steam whistle on the engine, no air-whistle or bell-cord signals, and—above all—with no uniform code of operating rules, early railway operation was crude in the extreme. Seemingly, the only practical method affording an approach to regular operation consisted in rigid adherence to time cards; and this was impossible on account of frequent derailments, the crude tracks in use, and the frequent breaking down of engines and cars. On busy roads locomotives were kept ready with steam up at convenient points to go to the relief of any belated train. Usually, the only warning that could be had of any trouble was the fact that a train did not arrive when expected. When the relief engine started out to meet the delayed train there was no means of telling whether the delayed train was just around the first curve or 20 miles or more away. Therefore, on a single-track road, it was necessary to flag around every curve. Headlights on night service engines with "powerful reflectors" were introduced on the Boston and Worcester in August, 1840.

In the very early days the engine driver collected passenger fares, and the brakeman handled the heavy baggage and the local freight that went by the same train. There was no conductor. Later, important trains were put in more responsible charge of an officer called the captain of the train. There was a deal of responsibility and authority to the old post of train captain or conductor, which no longer pertains to it. His position was somewhat similar to that of the captain of a sailing vessel, who is in responsible charge of the movements of the vessel, and of its passengers and its cargo, throughout the journey of uncertain duration. Some of the early train captains were elected by ballot by the board of directors of the company.

The report, in January, 1840, of the directors of the Camden and Amboy Railroad and of the Delaware and Raritan Canal showed some interesting results. The length of the journey from New York to Philadelphia had been decreased "from 11 to 20 hours to from 6 to 7 hours." The results of the operation of canal and road were as follows:

Expenses in construction	$6 064 953
Share capital	2 900 000

The remaining capital was borrowed at 6 per cent. For seven years there had been an annual increase in the profits of about 20%, and if this increase continued for seven years more the property would then be earning 28% dividends. The operating account for the seven years was:

Year.	Gross receipts.	Operating expenses.	Net receipts.
1833	$468 142	$287 092	$181 050
1834	546 993	313 262	233 731
1835	679 464	317 492	361 972
1836	770 621	363 345	407 276
1837	731 995	359 510	372 485
1838	754 990	355 249	399 741
1839	685 330	258 043	427 287

The report, further, showed that the railway had been very profitable, while the canal had barely paid expenses. The canal had cost $2 830 000, and had yielded a net profit of $96 500 in six years. The railway had cost $3 235 000, and in the same six years had yielded a net profit of $2 203 000.*

In 1840 Northern railroads generally, except certain coal roads, earned more from passengers than from freight; the Southern roads earned more from freight. Flour, coal, tobacco, and cotton were the principal commodities carried. Freight rates were so high that many articles now carried by rail could not bear the cost of movement. Live stock was driven on foot. Whisky was carried largely on the common roads. In the early operation of the Liverpool and Manchester the freight charge per ton-mile was between 8 and 9 cents. On the Baltimore and Ohio it was 6 cents, and it was about the same on the State road from Philadelphia to Columbia. In 1840 the flour rate from Pittsburg to Philadelphia was $1.55 per bbl., which was a little less than 4 cents per ton-mile. In 1838 the Mohawk and Hudson, in competition with the Erie Canal, carried flour at 4 cents and light goods at 6 cents per ton-mile. The Central Railroad, operated by the State of Michigan, charged 12½ cents per ton-mile on flour in 1838. The Petersburg Railroad, in Virginia, was prohibited in its charter from charging more than 12½ cents per ton-mile. In 1840 this same road was permitted by the Legislature to charge passengers 8 cents a mile. The Central Railroad and Banking Company, of Georgia, was prohibited in its charter from charging passengers more than 5 cents a mile. In 1837 passenger rates per mile were as follows on the lines named: Baltimore and Ohio, 3 cents; Baltimore and Washington, 6 cents; Portsmouth and Roanoke, 6 cents; Boston and Providence, 5 cents; Boston and Lowell, 3½ cents; Mohawk and Hudson, 5 cents.*

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* Ringwalt's "Development of Transportation Systems in the United States," p. 77.

A number of the States, such as Pennsylvania, Georgia, and Michigan, entered into the business of railroad construction and operation. State aid to railways in various forms was quite prevalent. In two of the Southern States, Georgia and South Carolina, State aid was successful. It was unprofitable in most other States. In these early days it was difficult to secure enough capital to build any great length of railway or canal unless the credit of the State stood behind the enterprise. Before 1842 Massachusetts had extended assistance to railways amounting to $5 500 000. In 1840 New York had helped railways to about the same extent. In 1839, $18 000 000 had been expended for railway construction in Pennsylvania, nearly $6 000 000 of which had been expended by the State on its own railways. New Jersey stood firm against all State aid. The Camden and Amboy, and the Delaware and Raritan Canal were constructed by a private company, which contributed about $3 000 000 in stock, and as much more was borrowed in England without the credit of the State. Pennsylvania found her canals burdensome and her railways unprofitable, though no great burden. In May, 1864, Commodore R. F. Stockton, who represented the New Jersey companies, wrote as follows:

"The experience of several states in the management of railroads and canals has proved that politicians could not do as well for the state with the public works as they could do for themselves. * * * In 1830 the people of New Jersey * * * had perceived the demoralization and deterioration of virtue, which already began to be flagrant in those states in which lavish expenditures for internal improvements, and vast state patronage, incidental to state management of public works, had taken place. Particularly they had marked the headlong and reckless precipitancy with which corrupt demagogues had plunged the noble state of Pennsylvania into the vortex of enormous debt."†

About 1840, Charles Ellet, Jr., wrote concerning the financial situation of American railways, as follows:

"'Some few have thus far sustained themselves, and distributed considerable dividends. The receipts of some others are sufficient to keep them in repair, and pay the interest on the loans incurred for their construction; but of the balance, having an aggregate length of some two thousand miles, the capitals may be regarded as positively sunk, and many of the companies as insolvent. * * * They make costly roads, build expensive superstructures, rear extravagant edifices to contain their cars and engines, run heavy locomotives, and use carriages almost as capacious as dwelling houses, to carry as many passengers as could, without much inconvenience, be drawn in a hand-cart. If railroads do not sustain themselves, it is not because they are railroads, but because great roads have been constructed where little ones only are required. * * * The power contrived to turn a grist mill would make but small dividends if applied to turn a churn.' "*

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* Authority for the amount of these rates and fares may be found in Ringwalt's "Development of Transportation Systems in the United States," pp. 106 to 111.

† Ringwalt's "Development of Transportation Systems in the United States," pp. 79 and 80.

The Country's Commerce, as Affected by Railway Development up to 1840.—Up to 1840 the railroads, though of great convenience and value to certain localities, had exerted little influence on the country's commerce. There was little interstate movement of the heavy commodities of modern traffic. There were but two transportation routes in operation connecting the Central West with the Atlantic seaboard cities: the Erie Canal and the State route through Pennsylvania, composed of part canal and part railroad. This second route, up to 1840 and for long years afterward, had little effect in deflecting traffic from the Erie Canal and New York City to Philadelphia. The annual east-bound traffic over the Portage Railroad during its period of operation, from 1834 to 1854, was said to be not more than 20 000 tons. From 1837 to 1854 the east-bound tonnage on the Erie Canal was never less than 612 000, and in 1853 it was 2 506 000. Thus far in railway development there had been realized little besides good grounds for high hopes for the future. The first continuous line of railway built with a view of reaching and controlling the streams of internal traffic was the Western Railroad of Massachusetts.

The Settlement of the Middle West.—As far as the West had been peopled, up to 1840, the year when railway traffic may be said to have begun to affect the development of the country, though the effect was feeble at first, it had been done by people traveling by raft or flatboat, or by saddle and pack-horse. The settlers carried to their new homes axes, rifles, bullets, and salt, and little else. Once over the Alleghanies, the streams flowed westward, and it was easy to go down with the current, but hard to move up against it. It was easy to get the produce of the West to New Orleans, but difficult to get even the person of the hunter or settler back over the Alleghanies. Therefore, many went and did not return. From 1790 to 1840 the population was moving steadily westward down the streams. In 1790 the center of population was east of Baltimore, in Chesapeake Bay. By 1840 it had traveled westward 221 miles and was across the Alleghanies. The Louisiana Purchase had placed the Mississippi River from end to end in United States territory. On the plains of the West the settler easily produced more than he consumed, and his surplus products went down stream with the river currents. The West was breaking away from the East.

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* Ringwalt's "Development of Transportation Systems in the United States," p. 81.

The Westward Development of the Railroads.—The last link in the lines of railway between Albany and Buffalo was completed in 1842; but, at that time, no one thought of the railway as competing for the traffic of the canal. The lines from the Ohio River and the lakes eastward never entered into competition with the canals until other railways were constructed from their western termini still farther west into the great interior. The traffic collected on the Lakes naturally clung to water routes all the way to the seaboard, while it was found that traffic originating along the railway lines in the interior tended to cling to the rail routes until it reached its final destination. By 1848 a line was constructed through from Lake Erie *via* Springfield to the Ohio at Cincinnati. The Cleveland and Pittsburg was put in operation in 1852, making another junction of Lake Erie and the Ohio, and the line from Buffalo to Toledo along the Lake in 1853. The Michigan Central and the Michigan Southern were opened in 1852. The Rock Island reached the Mississippi River from Chicago in 1854. In 1851 the Hudson River Railroad was opened, and in the same year the Erie was opened from the Hudson to Lake Erie. The Pennsylvania was opened through to the Ohio at Pittsburg in 1852, and the Baltimore and Ohio reached the Ohio in 1852.

In order to prevent the railway from competing with the Erie Canal, all freight over the New York Central was subjected to canal tolls, soon after the line was opened through; but, when the Erie road was opened, in 1851, on which no such charge could be placed, the Central was relieved of the canal tolls, and then the competition between the canal and the railway began in earnest.

"From 1853 to 1859 there was a fight for supremacy between canal and railroad. For twelve years more there was a contest for profits. Then it became a question whether the canal could pay expenses of maintenance; a question which was finally decided in the negative."*

The through east-bound traffic on both the Erie and the Central in 1852 footed up only 46 601 tons, while the canal carried east a through traffic twenty-five times as great; but in the next year it was only fifteen times as great. In 1854 the ton-mileage on the canal decreased by 31 731 000, while the ton-mileage on the Ogdensburg, Central, and Erie roads increased by 55 736 000. In the same year the revenues of the canal fell off $431 152, and those of the three railways named increased $1 520 688.†

Succeeding the great business depression of 1837, all public improvements in the United States were at a low ebb. The discovery of gold in California in 1848 instilled new hope and confidence, and the material development of the whole country comprising the United States may be said to date from this event; but the completion of the Erie road from the Hudson to Lake Erie and the consequent relief of the Central from canal tolls in 1851 may together be said to mark the real beginning of modern railway transportation methods and practice in the United States. Up to this date railway traffic had exercised small influence on the commerce of the country, except between local communities. The bulk of the railway business had been due to passengers. Even in 1851 the total gross income from passengers and from freight was about equal, $19 000 000 from the one and $20 000 000 from the other. Some idea of the magnitude of the change begun then may be obtained by considering the fact that in 1867 the freight business was 70% of the whole, a proportion which has since been fairly well maintained. The freight proportion in 1870 was 73%; in 1880, 76%; in 1892, 69%; in 1909, 75 per cent.

The successful competition of the railways with the canal was distressing to the adherents of canal traffic, but it meant the salvation and expansion of the great interior country. The West was now ready to return to the East. After being separated by water traffic, the two sections were to be reunited by rail traffic. The Pennsylvania Railroad was extended west from Pittsburg to Chicago by the completion of the Ft. Wayne road in 1858.

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* Hadley's "Railroad Transportation." p. 30.

† Poor's "Manual," 1881, p. xxv.

From 1850 to 1860 the railway mileage of the country increased 240 per cent. In the same decade the center of population made the largest stride it has ever made; from 1790 to 1900 it traveled westward 519 miles, or an average of 47.2 miles per decade, but from 1850 to 1860 it traveled westward 81 miles.

The Beginning of Railway Consolidation.—Separate short roads were now being combined under one management. In 1853 the New York Central was formed by combining what had been eleven companies. By 1858 this company had gained control of five other lines. Later there followed the union with the Hudson River road, the Harlem, the Lake Shore, the Canada Southern, the Michigan Central, and the New York, Chicago, and St. Louis, making up a system of 4 000 miles. The action of this line was typical. As long as traffic was local, each community could organize and run its own road to suit itself, but, when it was shown that the railways were to be the chief means of transporting through traffic, economy and satisfactory service both required uniformity in all conditions affecting traffic movement, and this was most easily secured by combining separate managements into one.

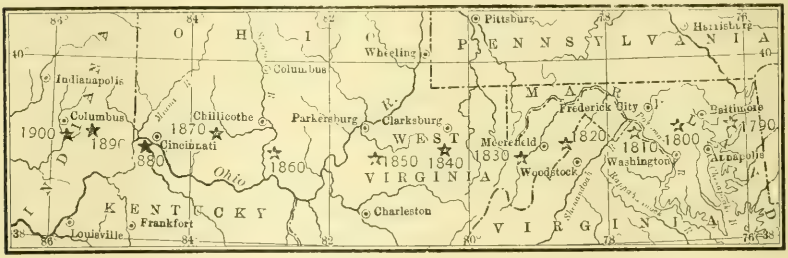

FIG. 1.

Railroad Construction Between Chicago and the Missouri River.—The reaching of the Mississippi by the Rock Island in 1854 was an important step. The produce of the country west of that stream, as well as that along the Illinois and the Wisconsin Rivers, heretofore had gone down stream. The Rock Island was closely followed by the Galena and Chicago Union (Northwestern), by the Chicago and Alton in 1855, and by the Chicago, Burlington, and Quincy in 1856. Lake Michigan and the Mississippi were united farther north by the Milwaukee and Prairie du Chien in 1857, and in 1858 by the Milwaukee and La Crosse (now the St. Paul), and in the next year the Hannibal and St. Joseph reached the Missouri River.

The Illinois Central was conceived and constructed to develop the Prairie State of Illinois. There were 705 miles in the original road. It was built in the form of a Y, standing north and south. Dubuque, Iowa, was at the apex of the western prong, Chicago at the other, while Cairo, at the junction of the Ohio and the Mississippi, was at the end of the tail. The first train was run in 1855, and the 705 miles were completed in 1856. The road paralleled watercourses, but was constructed with a view of bringing traffic to Chicago for shipment through the Lakes and the Erie Canal. By the time the road was made ready for traffic, however, the influence of the east and west roads was so strong in swerving traffic from the Lakes and the Erie Canal to their lines that the Illinois Central was brought face to face with a failing business in 1857, when the panic caused railway securities all over the country to fall in ruins. The remedy for the troubles of this line was eventually found in the construction of a north and south trans-continental line.

Trans-Missouri Development.—The settler and the hunter, ever pressing westward, found their progress a different matter after crossing the Mississippi and the Missouri. The current was now against them. It was 1826 before the first steamboat reached Lake Michigan, 1828 before it reached the Great Falls in the Missouri, and 1832 before it reached Chicago. But the West had found rude ways of getting up stream before the steamboat came. The fur trade in the North, the merchant trade in the far Southwest, and the freighting traffic to the mining regions of the West, each developed individual systems of transportation which were alike interesting and instructive. The natural routes to the Great West now lay along and up the Rio Grande, the Red, the Arkansas, the Platte, the Yellowstone, and the Upper Missouri; but the prices that the staple products brought in any mountain town in the trans-Missouri country previous to the advent of the railways reflects the ineffectiveness of the transportation. Calico, which was worth 10 cents per yd. in New York, might be worth $3 per yd. in Santa Fé, and a beaver skin was worth 50 cents on the upper Missouri and $3 in New York. As late as 1865 flour sold for a period of several weeks at prices ranging from $75 to $100 per 100-lb. sack in Virginia City, Mont. At the same place, in December, 1864, coal oil was quoted at from $9 to $10 per gal. As late as 1875, potatoes sold for 25 cents per lb. in the San Juan mining camps, and sugar brought from 35 to 50 cents per lb.* The development of the great trans-Missouri country could come only through the railway.

A writer in *The Emigrant,* a newspaper published for only a few years at Ann Arbor, Mich., in 1832, just three years after the opening of the Liverpool and Manchester road, proposed the construction of a route by rail from New York *via* the south shore of Lake Erie, and the Platte, Snake, and Columbia River Valleys, to the Pacific Coast. The writer of that article made profuse apologies for this proposition, and seemed to fear that his readers would consider him visionary or entirely out of his mind; but through trains on the New York Central, Lake Shore, Chicago and Northwestern, Union Pacific, and the Oregon Short Line traveled the route he then proposed during the lifetime of his contemporaries.

The construction of a Pacific road was frequently mentioned after this, and John P. Davis, in his "History of the Union Pacific Railway," says:

"In 1838, the idea of a Pacific railway had ceased to be novel, and the execution of the project was freely suggested, predicted, and urged in newspapers and magazines."

Bancroft says† that Thomas H. Benton, in a public address in 1844, predicted that men, full grown at that time, would yet see Asiatic commerce crossing the Rocky Mountains by rail.

Though the necessity of a Pacific railway was keenly felt, it is remarkable how many erroneous ideas prevailed in the popular mind in regard to it and the country it was to traverse. Emerson Hough‡ says:

"As late as 1855 it was announced as a settled thing that the continental route could not lie across the Northern Rockies, because in that region the heavy snowfall would block all railway travel."

So general was this opinion that the *Railroad Gazette,* in April, 1870, just after the first winter season in which the Central and Union Pacific had been in operation, announced as something remarkable that the operation of trains on these roads had not been at all impeded by snow during the season. In 1855 Henry Howe (in *The Great West*), expressed the opinion that the route up the valley of the Platte and over the South Pass was wholly impracticable.

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* Emerson Hough, in *The Century Magazine*, December, 1901.

† "History of California," p. 500.

‡ In *The Century Magazine*, January, 1902.

"The absence of timber on most of this route would prove an insuperable objection to its selection, even were it not ineligible from other considerations."

That the West itself was to become a great populous country, originating enormous traffic, was apparently not dreamed of at that time. Howe himself says that the country between the "most western limits of civilization and the recently settled territories of the Pacific is confessedly little known."

The Pacific road was to be built, but it was to thrive on oriental trade. The traffic between Europe and China, Japan, Java, and Ceylon, instead of making the weary journey around the southern capes of Africa or South America, was to hurry by rail across America to the cities of the Atlantic seaboard. From these cities, as the world's depots, the products of the Orient were to be distributed to European peoples. From 1840 to 1850 Asa Whitney, a well-to-do New York merchant, seems to have devoted all his time to the agitation of the question of building a Pacific railway, and to him, more than to any one else, is due the creation of the public sentiment which finally brought about the construction of the first Pacific roads. Whitney spent some years in China, and returned to America filled with the idea of constructing a Pacific road to bring the products of the Orient to the eastern coast of the United States. He made examinations and explorations at his own expense, and sent memorial after memorial to Congress. He visited almost every important city and every State in the Union, and went wherever he could get an intelligent body of citizens to listen to his dream, seeking to enlist them in his scheme of getting Congress to make the grants and pass the legislation which would bring about the construction of the Pacific road. His scheme for financing and operating the road was visionary, but, nevertheless, it dominated his whole life in an unselfish way, and brought forth fruit in due time, though never of any benefit to him. It is said that Whitney's entire fortune was spent in this undertaking, and that he was forced to peddle milk in Washington City for a living in the last years of his life.*

During the ten years immediately preceding the Civil War the construction of the Pacific railway was discussed by succeeding Congresses with more earnestness and attention than any other subject except the slavery question.* All parties were now agreed that a road should be built, but the selection of a route was a question upon which the sections were divided. *De Bow's Review* for May, 1854, said:

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* J. P. Davis, "The Union Pacific Railway," Chicago, 1894, p. 33.

> "Exploration has convinced every one that there are several ways of connecting * * * the Atlantic and Pacific by ordinary railways. The obstacle to be surmounted is, not the location of a route, but what route to choose of the number already located."

Divided on the issues of slavery, the North wanted a northern route and the South a southern route to the Pacific Coast. When the adherents of the southern route were withdrawn from Congress by the Civil War, federal legislation in the interest of a Pacific railway was at last possible. A Pacific Railroad bill passed Congress in 1862, and the final bill in 1864. The effect of this legislation was to place the eastern terminus of the road at Council Bluffs or Omaha.

In the selection of the eastern terminus of the road, there is evidence of the development of the country while the Pacific railway scheme was taking form. When Whitney first began his agitation, he contemplated constructing the road from Lake Michigan to the Pacific. Later, after Wisconsin had become a State, he advocated beginning the line on the Mississippi at Prairie du Chien.

It is no part of this paper to trace the financial history of this the first transcontinental railway, but it should be pointed out that the form of Government aid extended was an extraordinary piece of national legislation: one which could hardly have prevailed except in such excited times as those incident to the Civil War.

The first Pacific road was built as many a road in the United States has since been built. Long years were spent in deciding whether or not to build, and then construction was pushed with such frantic zeal that much inferior work was necessarily done.† In this railway construction 20 000 men worked as fiercely as though they had been battling for their lives. The results accomplished are perhaps best told by an eye-witness:‡

> "There will speedily be other railroads across our Continent. The rivalries of sections, the temptations of commerce, the necessities of our political system, will add at least two more through lines within a generation's time. But this, the first, will forever remain the one

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* F. H. Spearman, "The Strategy of Great Railroads." Scribner. 1904, p. 240.

† F. H. Spearman, "The First Trans-Continental Railroad."

‡ Bowles' "Our New West," Chicago, 1870, p. 68.

of history; the one of romance. Its construction in so short a time was the greatest triumph of modern civilization, indeed. The work was seriously begun on the California side in 1864: on the eastern end in 1866; and the early part of the year 1869 witnessed its entire completion. Considering that its length is over eighteen hundred miles; that much of it lay through an almost unknown and unexplored country; that it crosses two great continental ranges of mountains, and almost innumerable sub-ranges; that even the feeble centers of population along the line were five hundred miles apart; that for distances of from two hundred to five hundred miles there was no timber for ties; and for distances of fifty to two hundred miles there was no water for even drinking uses, and no grass to feed animals; that all the iron for one-half of the road had to be shipped around Cape Horn or across the Isthmus of Panama, and for the other to be freighted across the country from Pennsylvania—thinking of these elements of delay, difficulty and cost, surely neither argument nor rhetoric is necessary to place this work in its true proportions and its true relations before the world and in the pages of history."

Under the plan of construction adopted, the Central Pacific, a California corporation, built from San Francisco eastward and the Union Pacific from Omaha westward. The Government bounty money averaged $30 000 per mile, and the companies were enabled to issue and sell an equal amount of first-mortgage bonds of their own. Thus the cash funds available for the construction was nearly $60 000 per mile. Besides this, there remained the capital stock of the two companies and the land grant of half the land for 20 miles on each side of the road, amounting to about 32 000 000 acres. This reward, after the law of 1866 was passed, was open to the rival companies in proportion to the number of miles constructed. The Chicago and Northwestern pushed its lines through to Council Bluffs in the fall of 1867, and thenceforth the Union Pacific had a railroad as well as a river for its base of supplies. Ordinarily, the laying of a mile of track per day on a new line is considered good work, but in the race which ensued nearly 8 miles of track were laid in a single day. In their efforts to push the road, the Central Pacific hauled engines over the Sierras, but their difficulties were greater, as their country on the whole was rougher. They built 850 miles of the road, while the Union Pacific built 1 039 miles.

The two track-laying gangs met at Promontory, Utah, on the north shore of the Great Salt Lake, on May 10th, 1869. The last rail uniting the Atlantic and the Pacific was laid with great ceremony and nailed down to a laurel tie with spikes of silver and of gold, while the news that the East and the West were at last united by a road for the iron horse was telegraphed far and wide.*

As we have seen, the construction of other transcontinental lines had been contemplated. The United States Government had engineer parties in the field from 1852 to 1854. The famous document, the result of surveys made by these engineers, entitled "Reports of Explorations and Surveys to Ascertain the Most Practicable and Economical Route for a Railroad from the Mississippi River to the Pacific Ocean," included reports on five possible routes, the most northern one of which lay north of the 45th parallel, and the most southern one lay south of the 35th parallel, extending as far south at certain points as the 30th parallel. Since then each of these routes has been very closely followed by a so-called transcontinental road. The most northern route is occupied by the Northern Pacific, the next route south by the Union and Central Pacific, the next by the Denver and Rio Grande, the next by the Atchison, Topeka and Santa Fé, and the most southern by the Southern Pacific.

The Northern Pacific was chartered in 1864, before work was well begun on the Union Pacific. The history of its construction is an account of two decades of strenuous financial struggle.† Construction was begun in 1870, but the road was not completed until 1883. Before this date the Southern Pacific line, which shares with the Santa Fé the right to the term of "transcontinental road," was opened across the continent. The Texas and Pacific was chartered in 1872 to build from Fort Worth, Tex., to San Diego, Cal. While it was delaying construction and making appeals to Congress for aid, the stockholders of the Central Pacific in California, enriched by the liberal aid resulting from the construction of that road, organized in 1874 the Southern Pacific Railway Company of California, and consolidated under that name a number of small independent companies in that State. With their own resources they bought and built from San Francisco southeast through Southern California and then east across the Territories of Arizona and New Mexico, along the proposed route of the Texas Pacific, before that company had been able to cross the State of Texas. Through connection was established in 1882 by a junction with the Texas Pacific at a point east of El Paso. By the purchase of the Galveston, Harrisburg, and San Antonio, in 1881, and of the Morgan Railway and Steamship lines, in 1883, the Southern Pacific laid the plans for the consolidation in 1884 of all its allied lines under the name of the Southern Pacific Company of Kentucky.

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* "What *is* of consequence is the way in which the clicks [of the telegraph] were received, the blows repeated at San Francisco on the great bell of the City Hall, and cannon booming with the last stroke off Fort Point, and on Capitol Hill in Omaha a hundred guns following the explosion of bombs and the screaming of steam-whistles.

"It was the rejoicing of our crude days. Capitalists, prominent citizens, volunteer firemen, and horseshoers could still walk happily in one tireless procession when the last Pacific Railroad spike was driven. Grant took the news in the White House, Chicago turned out a parade four miles long, New York City was saluting the Pacific Coast with salvoes of artillery, Trinity chimes were ringing 'Old Hundred,' and Trinity voices were chanting 'Te Deum' when the earliest transcontinental line was finished; and in Philadelphia the old bells were ringing in Independence Hall." (F. H. Spearman in "The Strategy of Great Railroads," p. 261.)

† E. V. Smalley's "History of the Northern Pacific Railroad." G. P. Putnam's Sons, New York, 1883.

Contemporaneously with the development of the Southern Pacific was that of the Santa Fé. The Atchison and Topeka was chartered in 1859, and during its earlier years was developed as a Kansas agricultural road. Its lines slowly extended across that State, up the valley of the Arkansas, and finally (in February, 1879) along the Santa Fé trail, over the Raton Spur of the Rocky Mountains. In 1863 its name was changed to the Atchison, Topeka and Santa Fé. It finally joined the Southern Pacific at Deming, N. Mex., thus completing a fourth Pacific route. It was not until after 1888 that the main line of the Santa Fé, crossing north central New Mexico and Arizona, was connected directly with southern California across the scenic Grand Cañon of the Colorado.

The Canadian Pacific was the next transcontinental road constructed. This road shares with the Southern Pacific and the Santa Fé the right to the term, "Transcontinental," as it was constructed from tide-water on the St. Lawrence to tide-water on the Pacific. It lies just north of the United States boundary. This road was a political necessity in Canada, as much as was the Union Pacific in the United States, or more so. Its construction by the Canadian Government was rendered necessary by obligations assumed on the admission of British Columbia to the Dominion. Surveys for the road were commenced in 1871. Construction proceeded slowly until 1880, and then a new company was organized, and the enterprise was pushed to a rapid completion, through to Vancouver, in 1884.

The last so-called transcontinental line to be constructed was the Great Northern, which lies in the territory between the Northern

Pacific and the Canadian Pacific, almost entirely south of the Canadian boundary. Like the Northern Pacific, it now extends from Duluth-Superior, the head of navigation on the Great Lakes, and from St. Paul on the Mississippi, to the Pacific waters at several points in Washington. This was the last of the pioneer roads in the United States. Other roads may afterward be built in wild and inaccessible localities, but, since the construction of the Great Northern, there is no space left where a road can be built for hundreds of miles in practically uninhabited country. The Great Northern was fittingly constructed to close the chapter of pioneer railway building. In many respects its history is unique in the annals of railway construction. It was the first of the transcontinental lines to be constructed throughout by private enterprise, without any form of Government aid, either in land grants or subsidies. Through wise and careful management, it grew by a normal expansion from a local into a transcontinental road. The St. Paul, Minneapolis, and Manitoba was the parent of the Great Northern, and was built to connect the rich valley of the Red River of the North with the Mississippi at St. Paul. The line was extended through North Dakota to the Missouri, building numerous branches north to the Canadian border through the agricultural lands of North Dakota. It was extended west to the Missouri, along that river, and then west and southwest into the rich mining regions of southwestern Montana. The parent company was leased to the Great Northern in 1891.

The decision to extend the road westward to the Pacific Coast was made at about the time when popular interest began to concern itself about the commerce of the Pacific. The extension was begun from Pacific Junction in north central Montana, and the line was constructed rapidly over the Rockies and the Cascade Range and through to Puget Sound. This last of the pioneer lines of the United States was completed to the Pacific Coast in 1893, the year in which the Chicago Columbian Exposition was held in celebration of the four hundredth anniversary of the discovery of America.

The completion of this great work seems to have been signalized only by the kind of celebration which has sooner or later ensued on the completion of each of the pioneer railways, the kind which has meant so much for the progress and development of the United States.

The celebration consisted in an immediate material reduction in transcontinental freight charges.*

The successful construction and management of the Great Northern has been a wholesome refutation of the idea that such enterprises could be carried out in the United States only by using at first a system of over-capitalization which offered false hopes to investors, to be followed by a reorganization which would result in loss to the original stockholders.

In writing of the Great Northern in the *Railway World* of September 10th, 1904, Professor Edward Sherwood Meade says:

> "Here is a road which was originally constructed into a desert; whose original territory was almost destitude of population; a road which was forced to create its traffic as it went, and meanwhile to live off its previous accumulations of earnings; a road whose future was clouded in uncertainty. * * * Building up the country as they went they soon made the new mileage self-supporting and able to pay interest and dividends on capital, none of whose proceeds had been diverted from its original purpose of construction and equipment."

The center of population of the United States moved westward by quite regular steps from 1810 to 1890, except for the long stride, from 1850 to 1860, already referred to; but the pioneer work was well-nigh completed in 1890, and from 1890 to 1900 the westward progress of the star on the map was less than half the average distance moved per decade since 1790. From 1900 to 1910 incomplete census reports now indicate that it has moved westward hardly at all. The railroads had overtaken the West, and the East and the West were now united. Heretofore the strong young men of the East were wont to go and try their fortunes in the wilds of the West; but now, while Eastern youth still go west for their fortunes, Western youth go east for theirs.

The writer has followed railway development along east and west lines because the making of the country lay in the bringing of the East and the West into one. The traffic of the great trunk lines between Chicago and the Atlantic seaboard, and of the transcontinental lines from the Great Lakes and the Mississippi Valley to the Pacific, is now the pulse which indicates the health of the nation.

The United States, however, owes to its railroads even a greater debt in the development and union of sections separated along lines running more nearly east and west. As we have seen, the East and the West were divided by geographical conditions which were overcome by the railroads. The North and the South were divided by political conditions which were overcome by the railroads through the establishment of means of intercommunication which made the South a part of United America.

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* *The Railway Age*, February 24th, and June 16th, 1893.

The development of through railway traffic in the South was very much slower than in the country farther north. This was due partly to the fact that there was no large city on the eastern sea coast south of Baltimore, partly to the fact that the streams in the great interior basin generally flowed south, affording routes for getting produce to the sea coast unhindered by ice throughout the year, and partly to the fact that these streams had acquired such volume by the time they reached the southern part of the United States as to make their bridging very expensive by east and west railways.

Even to-day there are only two bridges spanning the Mississippi south of St. Louis, and none south of Memphis. The bridging of the streams in southern Alabama and Mississippi, which was necessary before through lines could be operated between New Orleans and Atlanta, Louisville, Cincinnati, and New York, was a task calling for the best efforts of the engineers of the country, a task which could not be said to have been accomplished satisfactorily before about 1872.

However, local lines were constructed between a number of important points before the Civil War. The Georgia Railroad joined Augusta and Atlanta (171 miles) in 1839. The Central Railroad of that State joined Savannah and Macon (191 miles) in 1840. The Western and Atlantic joined Atlanta and Chattanooga (138 miles) in 1850. The Atlanta and West Point, together with the Western Railway of Alabama, joined Atlanta and Montgomery (175 miles) in 1853. Nashville and Chattanooga (151 miles) were joined by a road of that name in 1854. Memphis and Chattanooga were joined by the Memphis and Charleston (310 miles) in 1857. The Mobile and Ohio was opened from Mobile to Columbus, Ky., on the Mississippi (472 miles) in 1859, and in the same year the New Orleans, Jackson, and Great Northern, together with the Mississippi Central, made up a continuous line of 442 miles from New Orleans to Jackson, Tenn. The Louisville and Nashville was also opened between the cities named (187 miles) in 1859, and between Louisville and Memphis by the addition of 262 miles more of road in 1861. The Mobile and Montgomery was opened from Montgomery to Tensas (164 miles), within 22 miles of Mobile by water, in 1862.

The first connection of continuous railway line penetrating the interior of the South and putting it in direct and quick communication with the country's Capital and the cities of the Atlantic seaboard may be said to have started at Alexandria, just across the Potomac from Washington; it crossed the State of Virginia diagonally to the southwest, and followed the general direction of the Blue Ridge Mountains into Alabama, Georgia, and eastern Tennessee. Though there were few through lines operated, rail connection was quite well established through the territory mentioned above by 1859.

During the Civil War, and for many a sad, long year afterward, railway development was very nearly at a standstill in the South. In 1860 30% of the railway mileage of the country was in the Southern States. In 1870 only 23% of railway mileage was in the South. From 1860 to 1870 railway mileage increased 91% in other parts of the country and only 35% in the Southern States. By the time that railway expansion began again, the economies to be gained by consolidating separate lines into continuous systems had been pretty well demonstrated by the lines farther north.

The Illinois Central was the first exterior road to push its lines into the South. This road, extending from Chicago and the Upper Mississippi to the mouth of the Ohio at Cairo, had been of great service to the Northern armies in the transportation of troops. Paralleling the Mississippi, it had found that it could compete successfully with the river, even for heavy traffic. In 1872 steps were taken to interchange traffic across the Ohio at Cairo with the two roads already named extending from New Orleans to Jackson, Tenn., and on December 24th, 1873, through traffic was opened all the way from Chicago, the metropolis of the West, to New Orleans, the metropolis of the South.

From the date of this peaceful invasion of Southern territory by a Northern road, two great changes were to be made in conditions which had hitherto materially affected the relations of the South with the remainder of the country. One of these changes was to be regretted, perhaps, while the other was most propitious. The immense steamboat traffic on the Ohio and the Mississippi, of which the

South was justly proud, was to be curtailed in the same manner as had been the traffic on the Erie Canal; and there was to come a happy end to the narrow local prejudices which had so long surrounded so many Southern communities.

At about the same time the Louisville and Nashville—a rival system—began to extend its lines from the Ohio River through the South. It reached down to the Tennessee River in Alabama by acquiring the Nashville and Decatur in 1872, and in the same year to the Alabama River at Montgomery by completing and controlling the South and North Alabama, which line was later to develop the wonderful coal and iron fields in the Birmingham district. It reached tide-water at Mobile in 1880 by acquiring the Mobile and Montgomery, and then in the same year joined the Illinois Central at New Orleans by absorbing the New Orleans and Mobile. By 1880 through lines of railway traffic and travel had been well established from New Orleans to Chicago *via* Memphis and Cairo; from New Orleans to the East, *via* Birmingham, Cincinnati, and Pittsburg, by both the Louisville and Nashville and the Queen and Crescent route over the famous Cincinnati Southern; by the Shenandoah Valley route *via* Montgomery, Atlanta, Chattanooga, and the Blue Ridge Mountains; and *via* the Piedmont Air Line through Montgomery, Atlanta, Charlotte, Greensboro, Danville, and Washington.

Instrumentalities by Which the Development of Railways Has Been Fostered.—Even this brief survey of pioneer railway development would be incomplete without some mention of at least two of the means of development without which railway construction must have waited many long years: One of these, the land grant, directly affected railway construction; and the other, the steel rail, directly affected railway operation. Without either one of these improvements, railway development would probably have been retarded a decade or more behind its present-day status.

The first land grant was made in September, 1850, with a view of establishing a trunk line from Lake Michigan to the Gulf of Mexico; it was received by the Illinois Central. On the whole, 155 000 000 acres have been donated to railways in land grants, for the purpose of encouraging railroad construction. The railways of all States and Territories west of the Mississippi were liberally aided by this means. The railways of Alabama and all the States on the eastern shore of the Mississippi, except Tennessee and Kentucky, were more or less indebted to land grants for their development.

Some account of the troubles experienced with the early forms of iron rails has already been given. Space is lacking to enter into a history of the development of the form and manufacture of the steel rail, but it may be mentioned that it is due to the homogeneity of steel that the rails of the present day finally fail largely by normal wear, or the abrasion of the rail head, rather than by splitting and lamination, as was the case with iron rails.

Steel rails were rolled in England in 1855, but after the process of manufacture had been introduced and improved in the United States, the first orders for steel rail were placed in 1867. The following record, compiled from Poor's "Manual," shows the rate at which steel rails supplanted those of iron:

Year.	Miles of track with steel rails.	Miles of track with iron rails.	Percentage of steel rails.
1867	....	......	00
1880	33 680	81 967	29.1
1885	98 102	62 495	61.0
1890	167 606	40 697	80.4
1895	206 546	28 652	87.8
1900	238 464	19 389	92.5
1903	271 013	15 249	94.7

There is no doubt that, since about 1898, the use of iron rails has been practically discontinued, except on the tracks of sidings and spurs infrequently used.

The greatest service the steel rail has rendered has been in permitting the use of heavier rolling stock and in adding to the safety of train operation, so that traffic could be moved at greater speed and with fewer interruptions; but it has also introduced great economies in the railway maintenance account. Comprehensive and reliable statistics of railway operating expenditures in the days of iron rails are not available, but, from the best records that could be collected by the late A. M. Wellington, M. Am. Soc. C. E., writing in 1887,* in the ten years from 1865 to 1875, the renewal of rail made up 28.9% and the renewal of ties 11.7% of the total expenditures for maintenance of roadway and structures. Statistics of railways show that, for the average of the three years, 1907-09, rail renewals made up 5.1% of this account and tie renewals 14.7 per cent. When iron rails were used they cost 2.5 times as much as ties. To-day, with steel rails, the ties cost 2.9 times as much as the rails. However, these ratios between rail and tie accounts do not measure accurately the economy in maintenance produced by the steel rail, because the actual and relative cost of ties has greatly appreciated on account of the diminishing timber supply.

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* Wellington's "Railway Location." New York, 1889, p. 120.

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THE DETROIT RIVER TUNNEL.

By Wilson Sherman Kinnear, M. Am. Soc. C. E.

To be Presented October 4th, 1911.

Historical.

That the building of some structure for the crossing of the Detroit River was not a new idea is evident from records showing that it was considered in 1867. Almost yearly since that date, schemes have been presented for handling railroad traffic across this beautiful river without the use of the cumbersome car ferries. To describe only the practical plans, omitting the many fanciful structures offered by inventors who have taken out patents for methods of tunneling, of building submerged tubes and new styles of truss bridges, would be a task to appal the most ardent enthusiast after only a brief examination of the many drawings, descriptive and otherwise, and the numerous files and other archives on this subject. Among the many plans seriously considered, the most noteworthy are: The tunnel started in 1872, and afterward abandoned, by the Michigan Central Railroad and the Great Western Railway (now a part of the Grand Trunk system); a draw-bridge in 1873; a high bridge in 1879; the winter bridge in 1883; a high bridge again in 1896; a high bridge in 1904; and the present tunnel plan, developed since the summer of 1904.

By reference to a map it will be readily observed that the Detroit River is one of the links in the chain of Great Lakes and the system of

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Note.—These papers are issued before the date set for presentation and discussion. Correspondence is invited from those who cannot be present at the meeting, and may be sent by mail to the Secretary. Discussion, either oral or written, will be published in a subsequent number of *Proceedings*, and, when finally closed, the papers, with discussion in full, will be published in *Transactions*.

connecting waters. It extends from Lake St. Clair to Lake Erie, a distance of some 28 miles. Its general direction is southwest, and, at Detroit, it is possible to perform the apparent paradox of going south to Canada. The river is about ½ mile wide at Detroit, and its depth is from 18 to 48 ft.; its current varies as the wind blows up or down stream.

The commerce of the Great Lakes, consisting of great quantities of iron ore from Lake Superior and wheat from Lake Michigan points to their destinations at Buffalo and other Lake Erie ports, and coal from Lake Erie and Lake Superior ports, must all pass through this magnificent river, often termed the "Straits of Detroit." The commerce of the Lakes passing Detroit is of a magnitude rarely known or appreciated. It exceeds in tonnage that of Boston, and approaches very closely the combined foreign and coast commerce of New York City. That passing the site of the tunnel in 1906 was more than 50 000 000 tons, as shown by Table 1.

TABLE 1.—VESSELS PASSING DETROIT.

Year.	No. (Estimated.)	Number of tons registered. (Estimated.)	Value of cargoes.
1879	18 794	12 000 000	
1902	33 000	39 328 098	$440 834 640
1903	33 113	37 453 796	471 917 830
1904	29 472	33 049 984	453 598 656
1905	35 599	45 912 622	522 888 751
1906	35 128	50 673 897	662 971 053
1907	34 149	53 959 769	697 311 302
1908	27 883	40 628 850	614 425 480

The following will serve to show the volume of carload traffic handled by the railroads across the river at Detroit yearly from 1875 to 1878, inclusive, and from 1897 to 1909. These figures have not been selected, but are published records. The marked yearly increase should prove interesting and instructive.

Year.	No. of Cars.	Year.	No. of Cars.
1875	173 708	1897	507 894
1876	192 107	1898	575 894
1877	179 716	1899	624 802
1878	210 490	1900	621 073
		1901	650 117
		1902	590 486
		1909	735 753

The railroads handling traffic across the Detroit River are equipped with large, self-propelling car ferries, operated not only at a great expense, but at a decided disadvantage during the winter, when the river is filled with ice. These boats are of various designs, carrying either two or three tracks. Each track of the largest boats will hold from six to eight freight cars, or three or four sleeping cars or coaches. Experience in operating them, covering a period of years and including all designs, has shown them to average about twelve cars per trip. This average is based on all classes of cars. It will thus be seen that through trains have to be cut into many sections and re-assembled on the opposite side of the river, requiring a large number of switching movements. In crossing the river and passing through the terminal yards contiguous thereto, freight trains consume from 3 to 8 hours within the approximate 5-mile limit of such operations, and a large percentage of this time is direct delay incident to transfer by ferry; the interruption to passenger trains is not nearly so great, due entirely to the character of the service.

Up to the time of the opening of the tunnel, when the Michigan Central Railroad abandoned its ferries, ten car ferries were used for the transfer of the railroad traffic at Detroit; nine were in constant service and, during the season of 1909, ferried 735 753 cars. As before mentioned, the boats are of various sizes and designs, the largest being 351 ft. long and carrying 24 freight cars. The majority are side-wheelers, but those of the most modern design have propellers fore and aft. The most successful iceboat has side-wheels and a single propeller. Aside from interference by the through commerce of the Great Lakes, there is no great difficulty in operating the boats during the summer; but, from December 1st to April 1st, the ice is a very serious menace to the safe and expeditious movement of these vessels. It is not often that they are stopped by thick ice, the interruption being caused in the main by slush and anchor ice near the shores. The accumulation of anchor ice in and near the slips frequently reaches to the bottom of the river, thus making a landing at times a question of hours.

The crossing of the different routes by the ferries causes the ice broken in each channel to drift downward, filling the one below, and thus establishing as the easiest crossing the one farthest up stream.

During the winter of 1887-88 the most powerful ferry then constructed, and now in operation, was fast in the ice for four days and unfit for service for a month. The river was blocked for two weeks, and traffic had to be diverted *via* Toledo to the East, and also by way of Port Huron, where the channel happened to be open. The winter of 1903-04 was unusually severe, and one boat was stuck in the ice for several days. This was in spite of the fact that the largest and most powerful ferry had just been put in service. During every winter a certain amount of traffic is diverted from the Detroit crossing to railroads to the north and south, and this diversion becomes more or less permanent both for passenger and freight traffic. In 1888 some elaborate figures were prepared showing a marked decrease in the percentage of through passenger business between the summer and winter. Between Buffalo and Chicago, the Lake Shore and Michigan Central Railroads have always been great rivals for the passenger business, and for the year ending April 30th, 1888, during the summer, the Lake Shore carried 54.61% of the passengers; during the winter, however, it carried 61.58 per cent. In other words, the Michigan Central's percentage decreased from 45.39 to 38.42% of all the through passengers carried by the two roads. The value of the passenger business thus lost cannot well be estimated, and once diverted may not return.

The loss to the Michigan Central, or to any railroad, by delay to freight, is equally hard to estimate. The fluctuation in earnings forms the best basis, and direct comparison can be made with operating costs. The results have shown enormous losses directly chargeable to the river crossing, and it is but fair to assume that a large percentage of the business lost by diversion is not recovered.

From this brief discussion of the commerce through, and the traffic across, the Detroit River, the reasons for long-continued study of the river-crossing problem by the railroads can be more readily understood and appreciated. Four very determined efforts were made to secure necessary Congressional legislation for building a bridge across the river, the first in 1873 and the last in 1896.

In 1873 a board of United States Engineers, under the direction of the War Department, spent the summer and fall collecting data as to commerce and river conditions at Detroit, making a report on December 24th,* with the following conclusions:

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* Report of the Chief of Engrs., U. S. A., 1874, Pt. 1, p. 602.

"1st. That a bridge giving a clear headway of 150 feet and clear spans of 400 feet, would not seriously injure navigation, * * *.

"2d. That no bridge giving passage to vessels by draws alone, with draw-spans at present practicable, can be permitted without serious injury to navigation.

"3d. That a bridge giving a clear opening of 700 feet from April 1 to December 1, with two draw-openings 100 feet in the clear, and with the permanent foundations of its movable piers 18 feet below lowest stage of water, will not be a serious obstacle to navigation.

"4th. * * * the board deem the crossing of the river by tunnels the only unobjectionable method * * *."

From this it will be seen that even the slight obstructions to navigation offered by the type of bridge considered did not meet with the approval of the Board of Engineers. The recommendation of the tunnel was voluntary.

In 1879 another effort was made to secure a charter for a bridge, with the result that a second Board was appointed, composed, as before, of U. S. Engineers, one member being the late Gen. O. M. Poe, M. Am. Soc. C. E. This Board also favored a tunnel, but was of the opinion that with skillful navigators there would be no material difficulty in passing through clear openings of 300 or 400 ft. at any time when it would be safe to navigate the river.

The fixed spans of the proposed bridge were to have clear openings of 450 ft., and the head-room was established at only 60 ft. One member of the Board would not concur as to the draw-bridge, and Congress took no action.

Again, in 1889, a board was appointed to investigate the crossing of the river by a bridge. This time the bridge considered was of novel construction. It was to be built in eleven spans, all except three of which would be removed in the summer, and the three central piers, supporting the four spans and covering a distance of 1 000 ft. in the center of the river, were to be removed to a depth of 40 ft., so that no vessel would ever come in contact with them. Fig. 1 is a profile of this novel scheme. The bridge proposed was for winter use only, hence its name, "The Winter Bridge." A strong effort was made to induce the Board to report favorably on this scheme, and a large amount of testimony was taken, which included testimony regarding a high bridge plan submitted by a third party. The Board* concluded as follows:

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* Report of the Chief of Engrs., U. S. A., 1890, Pt. 4, p. 3461.

"First. In their opinion it is feasible to build a bridge across Detroit River at Detroit, Mich.

"Second. That of the projects for a bridge submitted to them, that for a high bridge proposed by Mr. Lindenthal is the least objectionable and the most conservative of the shipping interests, and therefore the best plan.

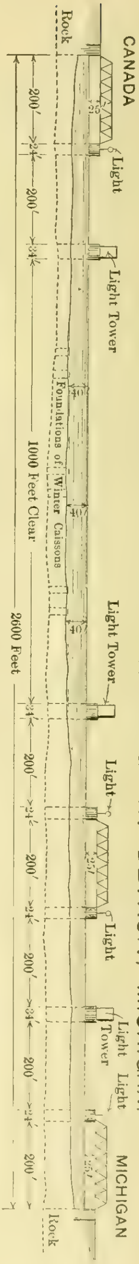
"Third. That project No. 2, for a winter bridge is the most practicable because it will accomplish the result sought at less cost, though justly subject to greater objection upon the part of navigators * * *."

It will be seen that for a third time the railroad failed to receive favorable consideration at the hands of the U. S. Engineers.

In 1896 another attempt was made to secure the necessary legislation for a high bridge. Under plans submitted at this time, the piers in the river were to be 1 130 ft. apart, but, as before, sufficient opposition was introduced to prevent the necessary action being taken. The opposition did not develop until the matter came before the Senate.

In 1904 the Grand Trunk Railway joined with the Michigan Central Railroad and employed the late George S. Morison, Past-President, Am. Soc. C. E., to select a site for a high-level bridge, which would be the best for all the railroads interested in the Detroit River crossing. The report made by Mr. Morison's successor had just been submitted, when the development of electric traction for heavy railroad traffic by the New York Central and Hudson River Railroad Company diverted somewhat the line of study, and assured the feasibility of the application of electric power to main-line traffic on heavy grades, thus eliminating one of the greatest objections to a tunnel,

THE PROPOSED DETROIT RIVER WINTER BRIDGE AT DETROIT, MICHIGAN.



This represents the bridge as proposed to be opened and lighted during the season of navigation. It was proposed to have one main opening of 1000 ft. and four of 200 ft. each; Total clear opening—1800 feet

Fig. 1.

namely, ventilation. The possibility of proper ventilation under all conditions of operation was the great element in bringing about the consideration of a tunnel instead of a bridge.

Tunneling under the rivers connecting the Great Lakes was not a new proposition by any means. In 1872 a tunnel was started under the Detroit River, and the Grand Trunk has been operating one at Port Huron, under the St. Clair River, since the early Nineties. The tunnel started at Detroit in 1872 was abandoned after a small drift had been driven from both sides of the river to within a few hundred feet of meeting. The drifts were intended to act as a drainage tunnel, and were also to assist in the alignment of the main tunnel. Many obstacles were encountered, and, owing to the excessive cost, the contractors asked to be allowed to stop work, which request was granted. The work was carried on for a time by the railroads, but was finally abandoned. The two greatest obstacles to progress were the presence of sulphur gas and sulphur water under a head higher than that of the river. When the drift finally filled, the water continued to rise, reaching the top of the shaft and overflowing to the river.

In 1890, after many discouraging setbacks, and troubles of an unexpected nature in building the approaches, the Grand Trunk Railway completed a single-track tunnel at Port Huron, under the St. Clair River. For many years steam operation had been a great drawback, and, although comparatively few fatalities are reported, it must be a relief to know that this tunnel was electrified in 1908.

In the fall of 1904, a committee, consisting of W. J. Wilgus, M. Am. Soc. C. E., Vice-President of the New York Central and Hudson River Railroad Company, the late E. A. Handy, M. Am. Soc. C. E., then Chief Engineer of the Lake Shore and Michigan Southern Railway, and the writer, as Chairman, was appointed by the Board of Directors of the Michigan Central Railroad to report on the feasibility of a tunnel under the Detroit River at Detroit for that company, based on data previously submitted by Gen. George S. Field, M. Am. Soc. C. E., of Buffalo. The report was to include recommendations as to grades, electrification, changes in terminals, estimates of cost, time required for construction, land necessary, etc. The Committee made the necessary investigations, reported favorably on the construction of a tunnel, and submitted estimates covering the different gradients for approaches, recommending a 2% grade west-bound and a 1½% grade east-bound. That the estimate, as then prepared, of the recommended tunnel was a good one, has been demonstrated by the actual cost of construction.

From the foregoing it will be seen that for thirty years the Michigan Central had endeavored to secure legislation favorable to the building of a bridge for handling traffic across the Detroit River, but was opposed at every turn. For a long time a tunnel was considered impracticable, under the conditions imposed and existing, but it has been made possible, not only by the development of the art of tunnel building, but by the development of the art of transportation through tunnels. It was not a difficult matter to secure the necessary permits from the two Governments for this international undertaking, as previous legislation, renewed from time to time as necessary, was passed to the constructing company, the Detroit River Tunnel Company.

Preliminary Work.

Preliminary and property surveys along the tunnel line as proposed were started in February, 1905. These surveys covered Michigan Central and adjoining property within the limits of the tunnel district in Detroit, and property in Canada from the river front to a point 4 miles east. Every effort was made to secure complete data of all sub-surface construction, such as pipe lines, sewers, conduits, foundations, etc. The location of the river tangent, near the ferry slips in Detroit and just above the Windsor Station on the Canadian side, was very favorable, as it fell within limits of property owned or controlled by the Michigan Central Company. The property surveys included the collection of all available information as to supports of buildings and structures adjacent to or on the tunnel line. To this end all plans of old structures which could be obtained were examined, and in the absence of reliable information in regard to the foundations, etc., explorations were made, and the nature of the construction was determined.

A large map, on a scale of 50 ft. to 1 in., was prepared, on which were recorded all the data furnished by the preliminary surveys and the final tunnel location. The location selected for the tunnel line in Detroit was adjoining the northerly right of way of the Michigan Central, from Baker Street to Lafayette Avenue, thence on a 2° curve to the right, crossing under the tracks as it approached the river. The

Canadian end was located entirely on property owned by the Michigan Central, but it forced the rebuilding of a terminal yard, as explained elsewhere.

In order to determine the nature of the material through which the tunnel was to pass, it was decided to take extensive wash borings throughout the entire length of the tunnel construction. Due to a possibility of the use of the shield method, it was not thought desirable to make borings in the exact line of the tunnel in the river section. As a result, two lines of holes were bored, 100 ft. down stream and 100 ft. up stream from the center line between the two tunnels; on these lines the borings were 100 ft. apart, and were carried to bed-rock. By reason of the uniformity of the material, this method gave sufficiently accurate determinations between the lines where the samples were taken. The work was done with the ordinary churn drill, consisting of a hollow 2½-in. casing, enclosing a $1\frac{5}{16}$-in. drill-bar, through which the water was forced to the bottom of the rod and returned through a perforated bit. As the water was forced upward from the bottom of the hole, it carried with it small particles of clay. The samples were collected at the top of the casing and preserved. The churning of the drill-bar cut the core to a large extent, and it was often impossible to determine accurately the exact nature of the material encountered. A more accurate determination was often made by withdrawing the drill-bar, taking off the bit and returning the bar, without closing the opening at the lower end. The bar was then forced and driven into the material until several feet of clay had accumulated. It was then withdrawn, water pressure was applied to the part which contained the clay, and the core was forced out. This core gave an accurate determination of the material, and sections were preserved in air-tight bottles for inspection. Throughout the limits of the tunnel the material was found to be a coarse, blue clay, of varying consistency, with occasional seams of sand and gravel, and scattered boulders. In addition to the borings, four test-pits, two on each side of the river, were sunk, and served to verify in every particular the character of the material as disclosed by the borings.

The river borings cost about 65 cents per lin. ft. More substantial floating equipment would undoubtedly have materially reduced this cost, although delays and interruptions are unavoidable in work of this description.

Alignment.—As the tunnel lies wholly within the limits of the right of way of the Michigan Central Railroad, it was thought advisable to make a complete new survey of all tracks and buildings, both in Detroit and Windsor, which might be affected by the work of construction, as previously mentioned. For convenience, the gauge line of the east-bound main passenger track was taken as a base line on both sides of the river, and to this all re-surveys were referred. The stationing was assumed so as to bring the zero mark about 1 200 ft. west of the Detroit city limits, and the numbering was carried continuously across the river, on the preliminary triangulation of the Windsor right of way.

For the preliminary triangulation across the river, a monument, formed by a rail splice-bar, was located in the Detroit yards, near the present site of the Detroit shaft, and for its stationing was tied into the re-survey base. On the Windsor side a monument was located near the river on the line of the gauge of the south rail of the east-bound main track, on the tangent east from London Street. To triangulate for the distance between these two points, a base was established on the Detroit side measuring 1 963.82 ft. A base was also established on the Windsor side measuring 1 607.40 ft. Only ordinary care was used in measuring these bases, as the survey was being platted to a scale of 50 ft. to 1 in. Each base was measured twice, checking within 0.05 ft. The angles were read with five repetitions and the means taken, which closed to 15 seconds. The two triangles gave values for the distances across the river varying by 0.37, and the mean was taken, which was close enough for platting the map on the scale used. The station of the Windsor monument was thus determined, and from this point the line was carried eastward along the tangent of the east-bound main track.

Elevations were taken on the top of the rail used as the re-survey base, to which were referred the levels for cross-sectioning at each station, and the topography. The datum used was that of the United States Government, being the elevation of mean tide at Sandy Hook. The surface of the Detroit River at the site of the tunnel, referred to this datum, has an average elevation of 574.2 ft.

Preliminary soundings to determine the depth of water in the river were taken in advance of the definite location of the tunnel line. These were supplemented by more accurate data, thus giving a correct cross-section of the bed of the river. The preliminary soundings were taken with an ordinary lead and line from a tug, the locations being observed by two transits set up at the ends of the preliminary base line on the Windsor side. The more accurate soundings were taken with a special machine, which consisted of a reel on which was wound a sounding line of steel piano wire. The plummet was of iron, weighing about 90 lb., of pointed oval form, with a wooden vane to keep it pointed up stream so as to offer little resistance to the current. The machine was mounted on a flatboat formed by two wooden pontoons, the wire passing down through the opening between them. The locations of these soundings were taken in the same manner as before. The soundings indicated a maximum depth of 48 ft. and a minimum of 18 ft.

There are two channels in the river in front of Detroit, one known as the Canadian channel, near the Canadian shore, and the other the central channel, located, as indicated by its name, near the center of the river. Observations covering a long period of years indicate that 90% of the commerce of the river passes through the Canadian channel.

Measurements to determine the current velocities along the tunnel line were taken in August and September, 1905, and showed a maximum velocity of 3.04 ft. per sec., or 2.32 miles per hour. The velocities recorded were sometimes greatly increased by strong southwest winds, when the water in Lake Erie is driven east, thus lowering its level at the mouth of the Detroit River and increasing the difference in level between Lake Erie and Lake St. Clair, thereby increasing the velocity of the current in the river, so that in all probability the maximum velocity is not far from 3.5 miles per hour; and one or more of the subaqueous sections was lowered when this maximum obtained. The extreme variation in the water level of the Detroit River is as much as 3 ft. above or below the mean elevation, 574.2 ft. The level has changed as much as 3 ft. in as many hours. As the direction of the wind has such a decided effect on the current in this part of the river, it is unfortunate that the most favorable weather prevailed when this work was in progress, hence there were no particularly interesting disclosures as to varying conditions.

The final survey consisted in the establishment of permanent monuments and bench-marks to be used as reference points for setting line, grade, and station points to control construction. Monuments were set on the approach tangents at the summits, at the points of intersection of the approach tangents with the river tangent, and at several convenient intermediate points. These generally consisted of pieces of scrap rail, about 4 ft. long, set in a 9-in. post-hole, with the top of the rail 1 or 2 in. above ground. The monuments were carefully tamped and allowed to settle for a day or two before marking. The river tangent was produced both ways beyond the points of intersection, far enough to reach high ground not likely to be disturbed, and monuments were set. These consisted of old 15-ft. rail switch-points, driven point down about 4 ft. into the bottom of a 10-ft. hole which was excavated so as to give a bottom diameter of about 3 ft., tapering to 2 ft. at the top, and the hole was filled with concrete around the rail. Witness monuments, consisting generally of scrap rail, were set so as to be readily accessible for checking the tangent monuments and, at the same time, not be likely to be disturbed. The east-bound tunnel had its approach tangents 21.5 ft. and its river tangent 26.4 ft. south of, and parallel to, those of the west-bound tunnel; no monuments were set especially for the east-bound tunnel, all lines for the latter being offset from the monuments set for the west-bound tunnel.

The final triangulation for the distance across the river, along the monumented west-bound tangent, was made from two base lines, one on each side of the river, the length of the Detroit base being about 942 ft., and that of the Windsor base, about 1 545 ft. In measuring these bases the tape was supported on stakes to bring it to a definite profile, the temperature correction was made, and a spring balance was used to indicate the tension, so that the proper comparison could be made with the U. S. Government standard. The mean values of a series of measurements on each line were taken, the extreme variation being 0.013 ft. for the Windsor base and 0.004 ft. for the Detroit base.

For the angles of the triangles, a "Berger" engineer's transit, graduated to read to 30″, was used. Special targets were devised for making long sights across the river. These consisted of pieces of board, about 12 in. wide and 20 in. high, painted white, on which were ruled two lines in the form of an **X**, having a slope with the vertical of about 22 degrees. The space on each side of the **X** was painted black, leaving two white isosceles triangles meeting in a point. In making sights across the river, the vertical cross-wires, as projected on the target, covered a space about ¾ in. wide, but by using this form of target it was possible to bisect the white triangles accurately, as the steep slope of the **X** made the apparent position of the points of the four triangles, appearing on either side of the vertical wire, sensitive indicators of error in sighting, whatever the apparent thickness of the wire. In reading the angles at each station, fifteen repetitions were added on the limb, reading from right to left, then fifteen turning left to right, and then two more sets of fifteen repetitions with the telescope reversed. Most of the readings were taken on cloudy days with a clear atmosphere, although during part of the time there was bright sunshine. This did not interfere materially, provided the sights were across open spaces and not alongside vertical surfaces which would reflect the heat and cause horizontal refraction.

The angles on each triangle were adjusted by distributing the error of closure among them. The angles for the triangle on the Windsor base line closed to 2.55″ less than 180°, and those for the triangle on the Detroit base line closed to 2.08″ less than 180 degrees. The distance across the river, along the west-bound, monumented tangent, computed from the triangle using the Windsor base line, had a value of 2 717.149 ft. The value given by the triangle on the Detroit base for this distance was 2 717.171 ft., making a difference between the two triangles of 0.022 ft., which was considered a very close check. These values were adjusted by giving a weight of fifteen to the length given by the triangle on the Windsor base line, and a weight of nine on the other triangle, being practically the ratio of the lengths of the base lines. Measurements through the completed tunnel check the triangled distances across the river almost exactly.

To obtain the exact values of the intersection angles between the tangents, the angles were read as in the triangulation. The targets for the sights across the river were similar to those described, but about twice as large. At the point of intersection of the river tangent with the Detroit approach tangent, a special tripod, about 10 ft. high, was erected over the monument, so that sights could be taken over box-cars which might be in the yards. This was of double construction, having one tripod inside and independent of the other, the inner one supporting the instrument and the outer one carrying a platform on which a man could stand without disturbing the instrument.

Stationing was adopted on the west-bound river tangents to correspond with those on which the borings in the river bottom were made.

This was also adopted later for the east-bound tangent, so that stations of the same number are opposite each other on the river tangents, allowing differences to accumulate around the curves to the approach tangents in both directions.

For transferring levels across the river, a special target, of heavy cardboard, 4½ by 7½ in., was ruled and painted like those used on the triangulation work. The target, however, was placed on the regular brass target, with the altitudes of the white triangles horizontal instead of vertical, and the long dimension of the card horizontal. The center of the target was set 2 in. above the zero of the vernier, and the card was notched sufficiently to permit the reading of the vernier, and to clear the head of the clamp-screw. In taking the levels, two 22-in. wye-levels were used simultaneously, one on each side of the river. Each was set up as near the dock front as practicable, and at a distance of about 200 ft. from the turning point, which was established on the dock, the distance between the turning points on the two sides of the river being about 2 400 ft. Fifteen readings were taken from each instrument on the near turning point and on that across the river alternately, white flags being used in signaling. The instruments were then exchanged, special care being taken not to disturb their adjustment, and two additional sets of fifteen readings were taken. Then the rods and rodmen were interchanged for a third set, and, lastly, the instruments were returned to their original stations for the fourth set. The mean of the eight sets of readings was computed for the difference of elevation of the turning point. By adopting this programme, all corrections for curvature of the earth's surface, refraction, inequality of back-sights and fore-sights, lack of adjustment of the instruments, and differences in the rods, were taken care of automatically. It was found impossible to work when the sun was shining, owing to variable refraction and heat waves, but with fine weather conditions, such as a cloudy sky and clear air, good results were obtained. The notes for any set of fifteen readings show no greater extreme variation than 0.08 ft., and three sets of twenty readings show an extreme variation of 0.03 ft. The difference in elevation between the turning points on the two sides of the river, as found, was fairly close; when checked by levels through the completed tunnel the error was 0.01 ft.

Line and grade points for the work in the headings were transferred from the surface through the various shafts. Monuments which were thought to be substantial were set in the headings, but it was found that all the points shifted more or less, owing to the unstable character of the clay, and had to be checked from the surface about once a week. Line points for the curves were referred to tangents, chosen so as to fall within the drifts. Offsets from these tangents at intervals of 5 ft. were computed to give the true line.

Organization.—In July, 1905, the Board of Directors of the Michigan Central Railroad Company appointed an Advisory Board of Engineers to have charge of the construction and electrification of the tunnel, consisting of the following members: William J. Wilgus, M. Am. Soc. C. E., Chairman; Howard A. Carson, M. Am. Soc. C. E., and the writer, as Chief Engineer. The local staff, immediately appointed, was as follows: Benjamin Douglas, M. Am. Soc. C. E., Tunnel Engineer; J. C. Mock, Electrical Engineer; A. C. Everham, Assoc. M. Am. Soc. C. E., Terminal Engineer and, later, Assistant Tunnel Engineer; and J. L. Holst, Designing Engineer. At about this time all the previously organized bridge and tunnel companies were consolidated under the name of the "Detroit River Tunnel Company," by which company the tunnel was built.

In advance of construction work, a complete testing laboratory was designed and built, on the water front in Detroit, on property owned by the Michigan Central Company. The main building is 22 by 48 ft., two stories high, and of fire-proof construction, with plaster walls, inside and out. The inspection of material was a very important feature of the tunnel work, and particular attention was given to cement. All cement used in the work was sampled at the mills, sealed in bins, tested at the laboratory, and shipped by the inspector from the mills in cars sealed by him. The seals were inspected at the destination and broken by a representative of the Tunnel Company before the contractor was permitted to use the cement. In this manner the contractor was relieved of all responsibility of inspection, and the cement was delivered to him as accepted. The cost of this testing laboratory. including equipment and a 300 000-lb., Olsen, screw testing machine, was about $20 000.

For the convenience of the engineers and inspectors, two field offices were built, one in Detroit and one in Windsor. These buildings contained lockers, shower baths, storerooms, dining-room, and kitchen. Meals were served four times a day for all employees of the Tunnel

Company. In the Detroit field office, a complete photographic outfit was installed, and a photographer was employed to take progress pictures of the work.

Plans, Contract, Etc.

The work of preparing plans was started in August, 1905, and by February, 1906, the contract drawings and specifications were handed to contractors with the request that proposals be submitted by March 26th, 1906. To aid in an analysis of the proposals, the entire work was divided into sections, as follows: westerly open cut; westerly approach tunnel; subaqueous section; easterly approach tunnel; easterly open cut; Detroit shaft; and Windsor shaft. Contractors were given the option of bidding on any or all sections.

The preliminary plans covered, not only approved designs for all the sections, but four alternative methods for constructing the subaqueous section. The contractors were given the option of selecting any one of the four methods for the subaqueous work, or submitting entirely new designs, or modifications of those suggested, restricted only to a compliance with certain conditions regulating stability, clearances, workmanship, etc.

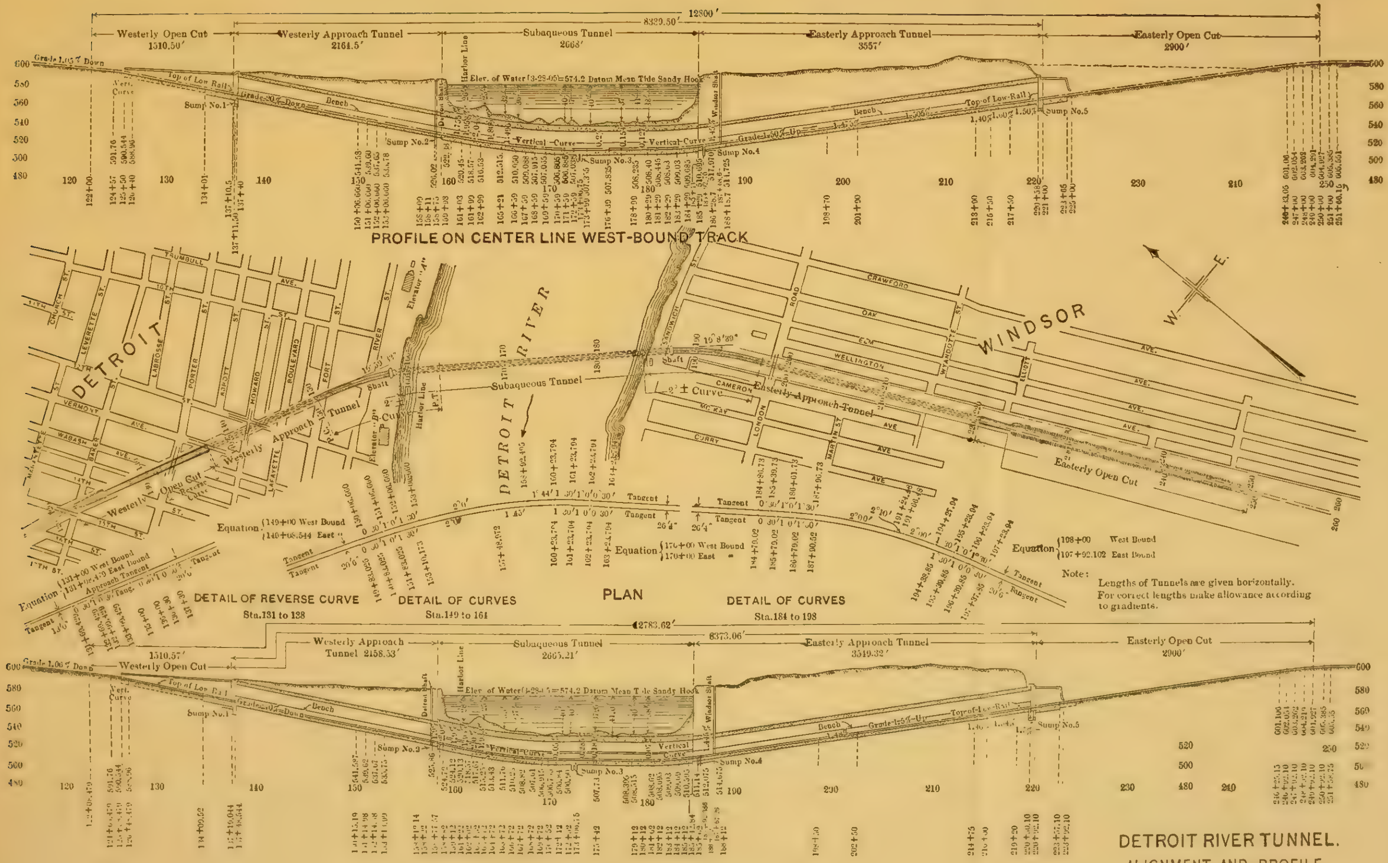
Three of the four methods suggested for the subaqueous section were entirely new, as applied to work of this magnitude, and the four alternative suggestions may be briefly described as follows:

Design A.—In its inception, as presented by Mr. Wilgus, this design contemplated the dredging of a trench across the river, on the line of the tunnel, of proper width, and to an established grade; the sinking and connecting of cores or forms to line and grade; the surrounding of these cores or forms with tremie- or bucket-deposited concrete; the unwatering of the interior of the cores or forms, and building in the opening thus provided a lining of reinforced concrete of dimensions sufficient to guarantee stability, continuity of strength, and water-tightness.

This method, although distinctly novel, presented several advantages, such as probable economy in construction, adaptability to higher grade line, and freedom from high air pressures—sufficient in themselves to demand careful study of the basic principles.

Design B.—This design, as presented by Mr. Carson, involved the dredging of a trench and the lowering to correct position therein of completed sections of a reinforced concrete tunnel, to meet the same

PLATE CVIII.
PAPERS, AM. SOC. C. E.
AUGUST, 1911.
KINNEAR ON
THE DETROIT RIVER TUNNEL.



PROFILE ON CENTER LINE WEST-BOUND TRACK

PLAN

DETAIL OF REVERSE CURVE
Sta.131 to 138

DETAIL OF CURVES
Sta.149 to 161

DETAIL OF CURVES
Sta.184 to 198

PROFILE ON CENTER LINE EAST-BOUND TRACK

DETROIT RIVER TUNNEL.
ALIGNMENT AND PROFILE.

requirements as those mentioned under Design *A;* the sections to be built in dry dock, towed to position, sunk, and joined under water. A sewer tunnel of comparatively small dimensions was built by Mr. Carson several years ago along these lines.

Design C.—This method was in the main a modification of Design *A,* and contemplated the use of steel forms.

Design D.—A shield-driven tunnel was specified under this heading, using cast-iron segments for preliminary protection, to be followed by a lining of concrete. In order to preserve the established gradients for the approaches and the economical location of open cuts, had this method been used, the covering over the shield operations under the major portion of the river would have been so light, without expensive blanketing, as to render the work extremely hazardous, if not entirely impracticable. The lowering of the tunnel grade line in its entirety, to avoid this marked element of danger, would have carried the shield into solid rock for at least 1 200 ft. in the center of the river.

The wording of the invitations to contractors, supplemented by the suggested designs, resulted in a number of bids and the submission of four independent designs. A very careful canvass of the entire situation by the Advisory Board resulted in awarding the contract for all the work to the Butler Brothers-Hoff Company.

The design for the subaqueous section submitted by this firm, was a modification of Design *A,* embodying some of the elements of Design *C,* accompanied by a large amount of detail covering the methods to be used in the prosecution of the work.

A lump-sum price was submitted for each section of the work, in addition to a schedule of unit prices covering various items. This schedule formed a part of the contract, to be used for the adjustment of changes in contract drawings as applicable to increased or decreased quantities.

The contract was awarded on August 1st, 1906. The work was started on October 1st of the same year, and completed on July 1st, 1910.

Tunnel.

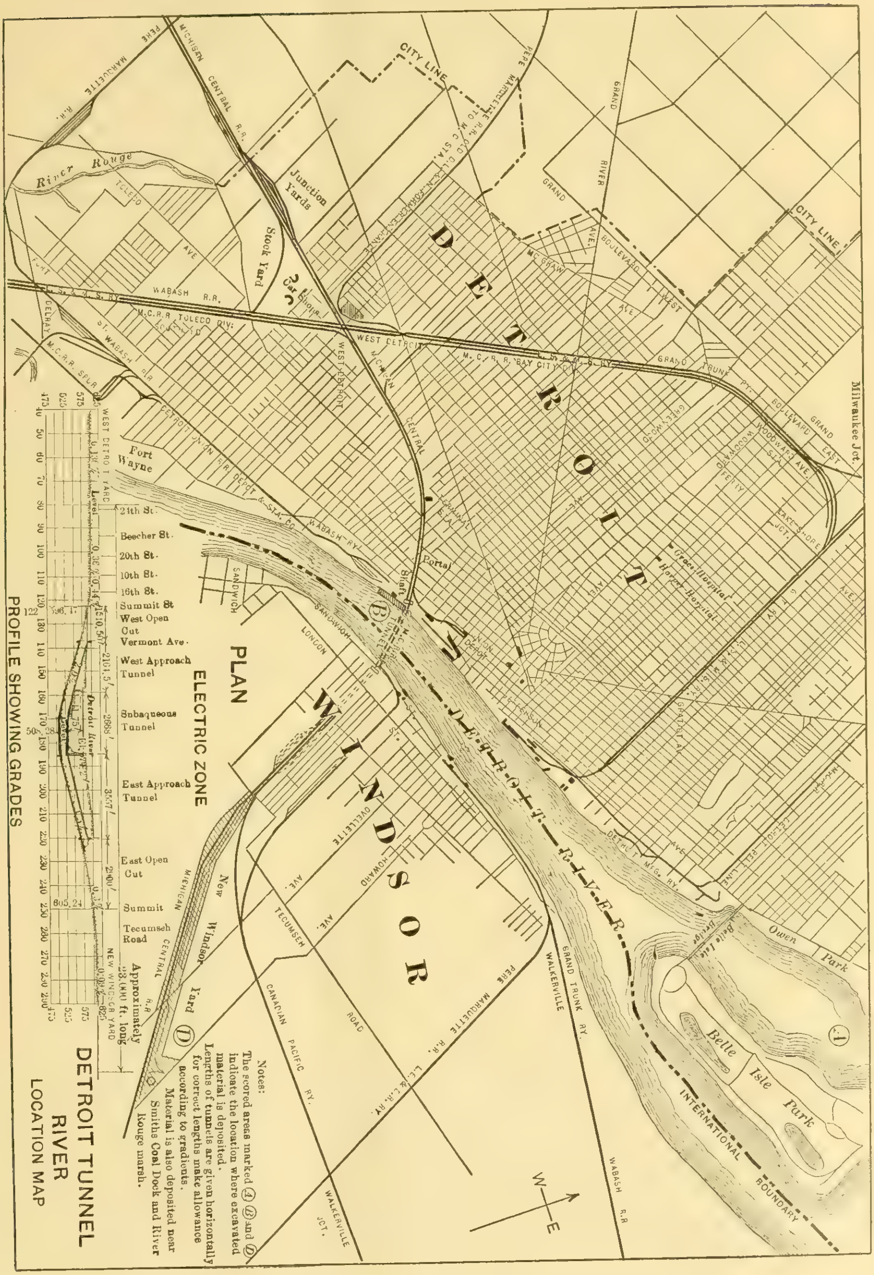
The tunnel work was naturally divided into three sections: The subaqueous, the westerly approach, and the easterly approach. The subaqueous section is 2 668 ft. long; the westerly, or Detroit, approach is 3 669 ft. long, including an open cut of 1 510.5 ft.; and the easterly approach, in Windsor, is 6 449.2 ft. long, including an open cut of 2 900 ft.

The general location of the tunnel and approaches is shown on Fig. 2. The alignment and profiles are shown on Plate CVIII. The tunnel consists of two single-track tubes, with a maximum gradient of 1.5% on the Windsor approach and 2% on the Detroit approach, compensated for curvature, and a maximum curvature of 2 degrees. The gradient for the Windsor approach was made the lower, favoring the heavier east-bound tonnage.

As previously stated, the entire structure is built through blue clay, the character of which varies considerably along different sections of the work. In Detroit it is fairly stiff, except for a distance of about 450 ft. back from the river, where it was soft enough to require the use of compressed air in the headings. There was an especially soft spot in this latter section adjoining an old test-pit, where the ground had become water-soaked. In Windsor the clay is more or less soft throughout, and when exposed in headings had such a tendency to flow that it was found necessary to use compressed air for nearly all tunnel work on that side of the river. Under the river the clay underlying the tunnel is very hard near the Windsor side, comparatively soft near the middle, and quite firm again approaching the Detroit shore.

Some tests made by the Tunnel Company in the easterly and westerly open cuts and in the headings in Windsor, shortly after excavation was started, with a view of determining the sustaining power of the clay, showed that a load of from 5 000 to 12 000 lb. per sq. ft. could safely be imposed at any point in the approaches without causing marked settlement. No reliable tests were made of the clay in the river-bed, in view of the results obtained in Windsor, where the original borings had shown it to be quite as soft as that under the river. Furthermore, it was demonstrated that any test made in from 60 to 80 ft. of water, where all the conditions could not be observed, would not be of much practical value.

The approach tunnels are built of plain concrete, without reinforcement, except for some longitudinal rods in the inverts, short transverse rods under the ties, and, for a short distance in Detroit, some special reinforcement where local conditions demanded it. The retaining walls in the open cuts are of the gravity type, with steel rails placed longitudinally in the footings and vertically in the back of the walls.



Notes:
The scored areas marked Ⓐ Ⓑ and Ⓓ indicate the location where excavated material is deposited.
Lengths of tunnels are given horizontally for correct lengths make allowance according to gradients.
Material is also deposited near Smiths Coal Dock and River Rouge marsh.

Fig. 2.

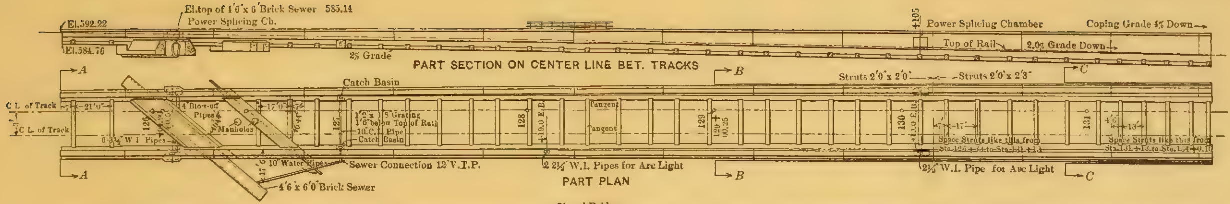
The subaqueous section of the tunnel is of unique construction, involving new methods of work, and will be described in detail later.

Westerly Open Cut.

The westerly open cut is along the northerly right-of-way line of the Michigan Central Railroad, in Detroit, extending from Fifteenth Street to Vermont Avenue. On account of the limited width of the right of way at this point and the consequent need for preserving as much of it as possible for yard purposes, the cut is enclosed by retaining walls. A cross-section of these walls, as built near the portal of the tunnel, is shown on Plate CIX. The execution of this work involved the removal of the three most northerly tracks, including the west-bound passenger track, leaving the east-bound passenger track, which was operated during the work as a single track, and three through tracks south of the single main track. The east-bound track, on account of its proximity to the cut, was supported on piles east of Baker Street.

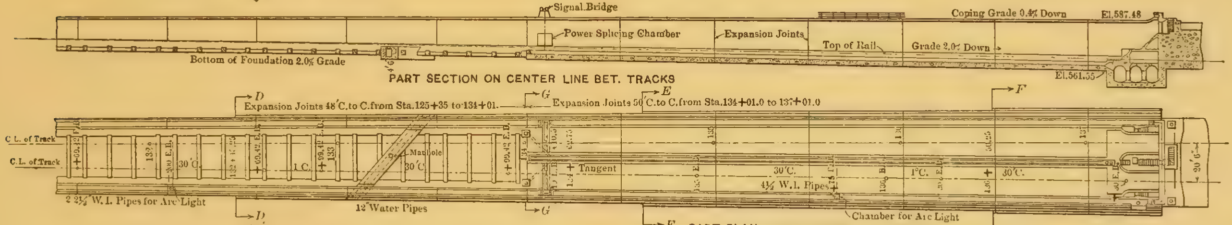
Excavation.—The excavation was made entirely by steam shovel, which necessarily worked in rather cramped quarters on account of the limited width of the cut, and was somewhat handicapped by having to pass close to several abutments and piers and over quite a number of city water mains. Further interruptions were caused by an infrequent train service, which was necessarily poor on account of the limited yard room. In spite of the many drawbacks, however, the steam-shovel work proved to be economical. The total excavation for this cut was about 38 000 cu. yd.

Concrete.—To secure a structure as nearly monolithic as possible, the concrete in the walls was placed in sections 48 or 50 ft. long, and in one run from the top of the footing to the under side of the coping. The backs of the walls were water-proofed by the application of one layer of coal-tar pitch down to the weep-holes, which are spaced at about 15-ft. centers along the walls. Where the walls are high and the pressure rather heavy on the underlying material, inverts were constructed, as shown on the cross-section, extending from wall to wall. Where the invert was not used, struts, 2 ft. square, were placed at intervals of about 15 ft., thus providing at every point for holding the walls apart.



PART SECTION ON CENTER LINE BET. TRACKS

PART PLAN

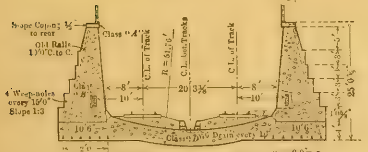


PART SECTION ON CENTER LINE BET. TRACKS

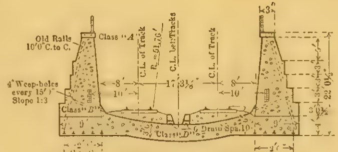
PART PLAN

TABLE OF CONCRETE PROPORTIONS

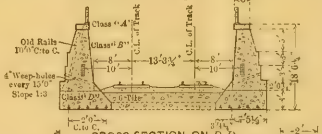
Class "A"	1 Cement,	2 Sand,	4 Gravel
" "B"	1 "	3 "	6 "
" "D"	1 "	4 "	7½ "



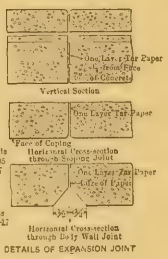
CROSS-SECTION ON *F-F*



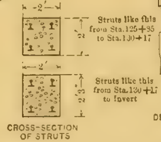
CROSS-SECTION ON *E-E*



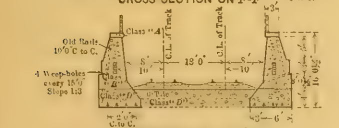
CROSS-SECTION ON *D-D*



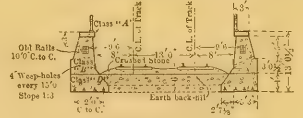
DETAILS OF EXPANSION JOINT


2'
Struts like this from Sta.125+35 to Sta.130+17
2'
Struts like this from Sta.130+17 to Invert

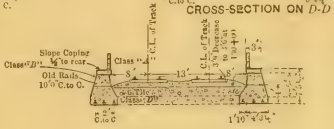
CROSS-SECTION OF STRUTS



CROSS-SECTION ON *C-C*



CROSS-SECTION ON *B-B*



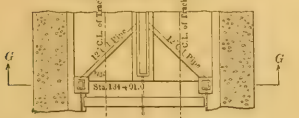
CROSS SECTION ON *A-A*

Notes:-

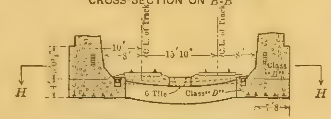
All Elevations refer to datum mean tide Sandy Hook, N.J.

All exposed corners and edges of concrete to be rounded to 1" radius unless otherwise specified.

Back of wall above weep-holes to be water-proofed with one coat of straight run coal-tar pitch ⅛" thick, Class "D"



CROSS-SECTION ON *H-H*



CROSS-SECTION ON *G-G*

DETROIT RIVER TUNNEL.

DETAILS OF WESTERLY OPEN CUT.

Within the limits of the cut, the track centers are reduced from 20 ft. 6 in. at the portal, which is the distance between the tracks on the tangent in the approach tunnels, to 13 ft. 0 in., the standard distance between the main-line tracks on the Michigan Central Railroad. This was done within the limits of the cut, so as to retain as much of the yard room as possible for future use. The change in line was made entirely in the east-bound track, and the south wall was built on a reverse curve, leaving the north wall on a tangent.

The walls are of three grades of concrete: A 1:4:7½ mixture in the footings; a 1:3:6 mixture in the body of the wall; and a 1:2:4 mixture in the coping. The specifications required a mortar face, but it was found that better results were obtained by carefully working the concrete at the face of the wall.

The fence on the top of each wall is composed of three lines of wrought-iron pipe, supported at intervals of 6 ft. by vertical wrought-iron posts, 2 in. in diameter. The diameter of the upper line of pipe is 2 in., that of the two lower lines is 1½ in., and all are parallel with the coping. Over every joint in the retaining wall a length of pipe slips into a sleeve on one of the posts, so that the expansion and contraction of the pipes will not mar the alignment of the fence.

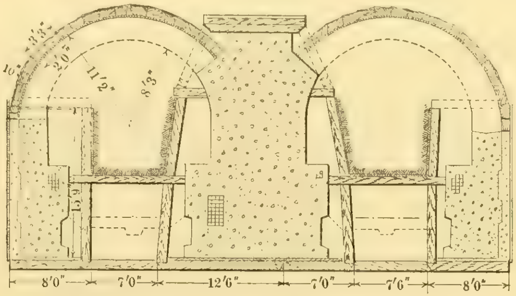
Drainage.—To prevent the collection of water behind the walls, in addition to the weep-holes, blind drains extend from the top of the wall to the weep-holes, and there is a porous back-filling of cinders or gravel. The method of taking care of the water which will naturally drain to the open cuts and the tunnel will be described later. As much surface-water as possible is caught in catch-basins and conducted directly to a sewer before it reaches the cut.

Design of the Approach Tunnels.

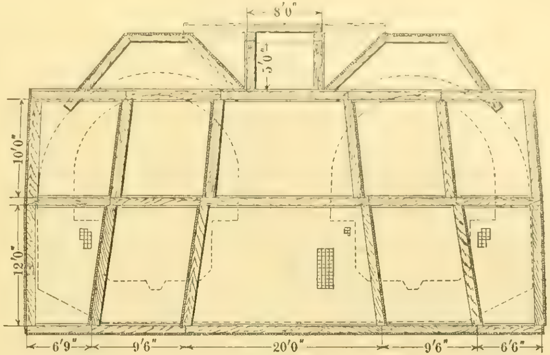
Inasmuch as the approach tunnels, as built, have two distinctly different cross-sections, it is appropriate that conditions giving rise to such difference in design should be explained at the outset. Cross-sections of the approach tunnels are shown on Plates CX and CXI. Types B, C, D, E, and F, represent practically the original designs, made before the contract for the work was awarded, when it was expected that the tunneling for the approaches throughout would be made in several headings or drifts, which would include the walls, arches, and inverts, and provide working space, but would not include the full tunnel section. The modified elliptical sections were made necessary by the subsequent adoption of the shield as a means of making the excavation. The contractor planned originally to use the drift method for all approach tunnel work, but shortly after the work was started, it was found that, on account of the character of the clay, such a method was impracticable for building the full tunnel section, either in Windsor or in Detroit. The difficulties and problems as they presented themselves were somewhat different on each side of the river.

In Windsor the clay was so soft throughout that it flowed into the drifts almost before the timbering could be placed, and in some places it came in at the working face about as rapidly as it could be mined out. There was also considerable lateral movement of the drifts, due, possibly, to unequal loading of the ground surface, showing that the clay acted like a fluid and would have to be treated as such. At the time these conditions were encountered, one drift, on the Canadian side of the river, had been carried about 2 000 ft.—the bottom drift for the center wall—and work had been started on the top drift for this wall, but had to be abandoned. A cross-section of the center-wall drifts, as first planned, is shown on Fig. 3. It might have been possible to carry on the work in drifts under high air pressures, but the expense of such a method, if applied to the entire tunnel, was considered prohibitory. Later, 80 ft. of the Windsor Tunnel, near the river, was built entirely in drifts under compressed air. Conditions which will be described later rendered such action necessary and advisable. Except for this portion of the tunnel and a section near the east portal, where the work was done in an open trench, the character of the material was such that the contractor found it advisable to drive the excavation for the center wall first. The wall was then built, and served as a guide for the two side shields of full tunnel section, which followed closely thereafter.

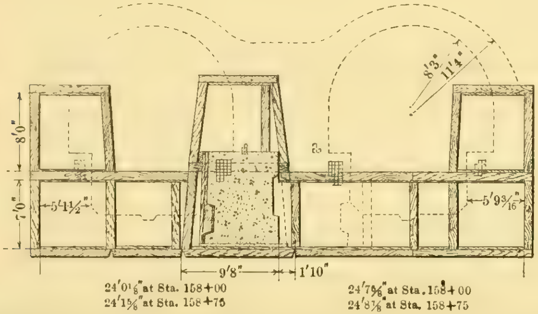
For the Windsor approach, a shield was used for the center wall, working above the bottom drift previously mentioned, and about 2 000 ft. of wall was built in this manner. This shield was of special design, was driven by hydraulic power, and excavation was made without the use of compressed air. The shield was abandoned at a point near where the center wall widens, approaching the subaqueous section, and the remainder of the wall was built in headings under compressed air.



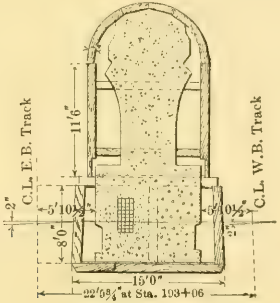
TIMBERING OF ARCHES IN WESTERLY APPROACH.



TIMBERING FROM STATION 185+43 TO STATION 186+21.



TIMBERING DETROIT APPROACH BETWEEN STA. 158+00 AND 158+75
SECTION AT STATION 158+75 LOOKING EAST.



TIMBERING OF CENTER
SHIELD DRIFT.

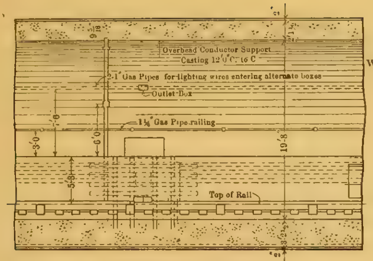
FIG. 3.

The movement of the center shield was very erratic at times, increasing with the depth of the overload, and had about reached its limit when abandoned.

The side shields were somewhat elliptical in shape, thus avoiding excessive increase in tunnel section. The cutting edge extended from the top of the center wall around to the bottom, including the arch, side-wall, and invert. The tunnel section was modified accordingly, as shown on Plates CX and CXI, and the shield was built to conform thereto. The modified section is practically the same as the original, the effective thickness of ring having been maintained throughout. The side shields were used successfully, with and without compressed air, as conditions demanded.

The drift method was abandoned for the westerly approach tunnels, except for the center wall, but for reasons somewhat different from those demanding a change in design for the easterly approach. In Windsor the difficulties encountered affected only the work itself, with, perhaps, the single exception of a section where the tunnel passes under an overhead bridge, carrying Sandwich Street over the tracks of the Michigan Central Railroad. In Detroit a number of surface structures along the line of the tunnel had to be maintained, in addition to the main and yard tracks of the Michigan Central Railroad. While it cannot be said that a greater part of both tunnel arches could not have been built successfully under the drift method, yet there were sections where local conditions made such a method thoroughly impracticable. Experience with the first center-wall drifts showed that excavation in the drifts was invariably followed by considerable settlement of the ground surface above, due, undoubtedly, in a large measure, to the draining of the water from the clay. Experience proved that, if a number of drifts had been in operation at any one time, the settlement of the ground surface would have been a very serious matter, and the resultant property damages heavy.

With the use of the shields, each working to the full tunnel section, the water-proofing was carried along as rapidly as the material was excavated, thus preventing seepage into the tunnel and consequent settlement of the ground surface. A portion of the westerly approach tunnel, near the portal, was built by the cut-and-cover method, which was also applied to a 400-ft. section in Windsor. A description of the approach tunnel work in detail follows.


Overhead Conductor Support Casting 12'0" C. to C
2-1" Gas Pipes for lighting wires entering alternate boxes
Outlet Box
1¼" Gas Pipe railing
Top of Rail
10'-8"
6'-0"
3'-0"
5'-8"

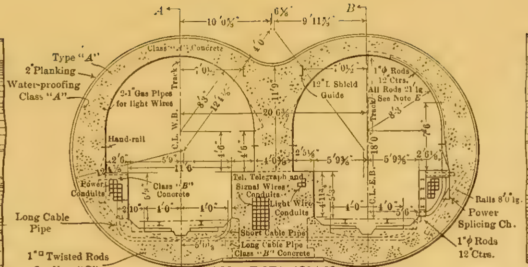
LONGITUDINAL SEC. *A-A*

TABLE OF CONCRETE PROPORTIONS

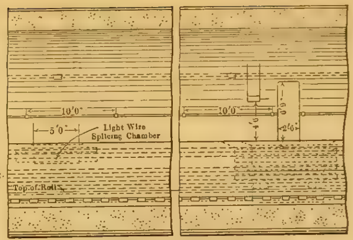
Class "*A*" 1 Part Cement, 2 Parts Sand, 4 Parts Broken Stone or Gravel
Class "*B*" 1 " " 3 " " 6 " " " " "
Class "*D*" 1 " " 4 " " 7½ " " " " "

NOTE:

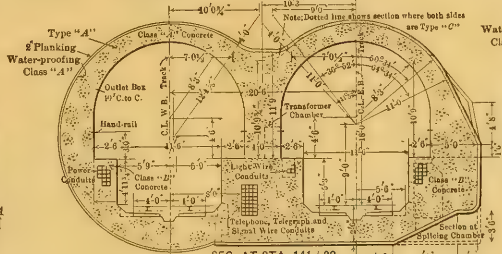
Class "*C*" Water-proofing from Subaqueous Tunnel to Shaft
" "*B*" " for 200 ft. West from Shaft
" "*A*" " for the remainder of tunnel



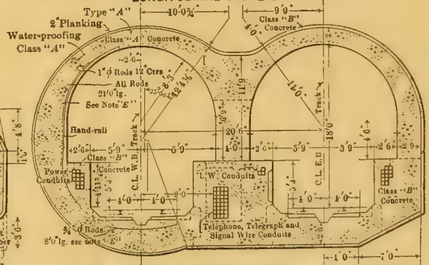
SEC. AT STA. 150+02



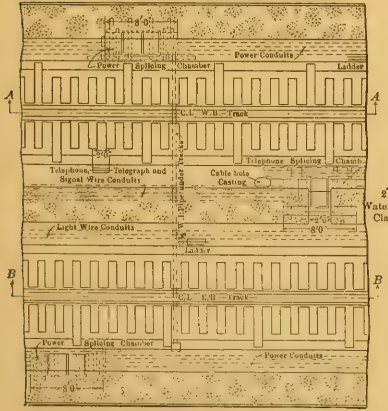
LONGITUDINAL SEC. *B-B*



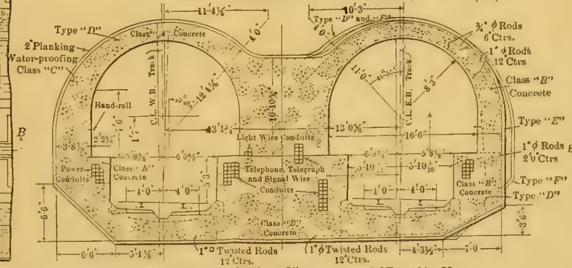
SEC. AT STA. 141+90



STA. 145+00



PLAN



SEC. AT STA. 158+53 See Note "*D*" SEC. AT STA. 158+20

Notes:
"*A*" Dotted lines at Sta.141+90 show section when both W.B. and E.B. Tunnels are built according to Type "*C*"
"*B*" This section to be used for W.B. Tunnel only from Sta.139+59 to Sta.140+96 see section at Sta.141+90 Type "*C*"
"*C*" Transverse reinforcement in invert rods ¾" ϕ rods placed under each tie in W.B. Tunnel Sta.144+18 to 149+44 and in E.B. Tunnel Sta.139+08 to 140+32 E.B. and Sta.146+58 to Sta.147+83 E.B.-Rods placed in center of space between ties, in W.B. Tunnel Sta.137+40 to 141+81, Sta.149+44 to 157+92 and Sta.158+23 to 158+75 in E.B. Tunnel Sta.137+48.5 to 139+08 E.B. Sta.147+83 to 157+97 E.B. and Sta.158+27 to 158+77.57 E.B.
"*D*" Longitudinal reinforcement in invert of 1" □ twisted rods, in W.B. Tunnel Sta.137+40 to 141+31. Sta. 144+18 to 157+92 and Sta.158+23 to 158+75, in E.B. Tunnel Sta.136+48.5 to 140+32 E.B. Sta.146+58 to 157+97 E.B. and Sta.158+27 to 158+77.57 E.B.
"*E*" Reinforcement of North wall of 1" ϕ rods Spaced 6" C. to C. is put in from Sta.142+66 to 148+50 W.B. and of South Wall from Sta.149+93 to 151+40 E.B on account of proximity of heavy retaining wall and bridge abutments.

DETROIT RIVER TUNNEL
DETAILS, WESTERLY APPROACH TUNNEL

Westerly Approach Tunnel.

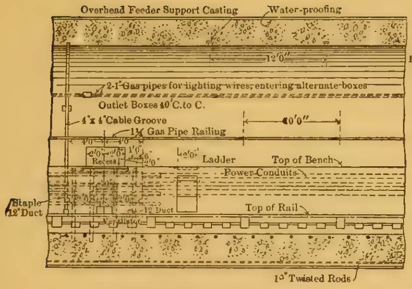
The westerly approach tunnel extends from Station 137 + 40, the end of the open cut, to Station 158 + 75, about 60 ft. west of the dock line at the river, where connection is made with the subaqueous tunnel. For 1 375 ft. it follows, on a tangent, the northerly right-of-way line of the railroad to Station 150 + 15, from which point it curves to the right on a 2° curve to the river. This portion of the work involved 100 000 cu. yd. of excavation and 40 200 cu. yd. of concrete.

Excavation.—From Station 137 + 40, the station at the portal, to Station 139 + 60, the material was removed by steam shovel at the same time that excavation was in progress for the open cut. From Station 139 + 60 to Station 144 + 50, the center wall and east-bound tunnel section were built in open trenches, as was also the west-bound tunnel section from Station 139 + 60 to Station 141 + 80. The center-wall trench was first excavated and the wall built, then followed the side trenches, braced to the center wall. The west-bound trench was not carried beyond this point on account of the work involved in supporting a bridge abutment at Howard Street. The other trenches would probably not have been carried farther than the west-bound trench, had it not been for the previous construction in headings, between Stations 144 + 50 and 146 + 20, of a section of the east-bound tunnel, thus making it necessary to start the east-bound side shield as far east as Station 146 + 20. The west-bound shield was started at Station 141 + 80. Excavation for the center wall, east from Station 144 + 50 to the permanent shaft at Station 158 + 09, 66 ft. west of the connection with the subaqueous tunnel, was made in headings, part of which, east of Station 154 + 26, was done under compressed air. It will be noted from the profile that the top of the tunnel at the west portal is within about 2 ft. of the surface of the ground, and at Station 144 + 50, the east end of the open trench work, it is within about 8 ft., so that the deepest part of the trench was 30 ft.

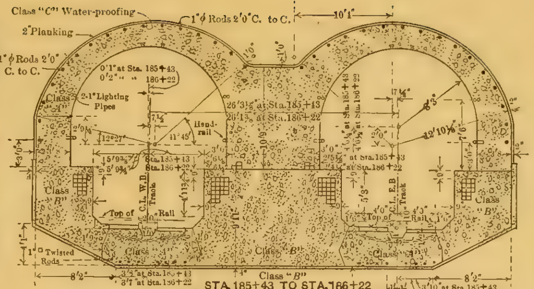
Work in the headings was carried on at first from two shafts, one of which is the permanent shaft at Station 158 + 09, and the other a small temporary shaft at Station 145 + 60. Later, a small shaft was sunk at Station 154 + 26 for handling the work in compressed air, east from that station. The permanent shaft, known on the work as Shaft No. 1, was sunk by the Tunnel Company early in 1906, for the purpose of expediting the work, and before the contract was awarded. This shaft, as excavated, was 20 by 60 ft., covering both tunnels. When the contractor came on the work, in the fall of 1906, the shaft was turned over to him to be used as a base of operations and to be maintained and completed in accordance with the contract drawings. The first temporary shaft, known on the work as Shaft No. 2, was sunk by the contractors directly after they took over the work, and was just large enough to include the center wall.

The headings were started west from Shaft No. 1 and east from Shaft No. 2 at about the same time, early in the fall of 1906. Work from Shaft No. 1 was in two headings, one over the other, measuring, respectively, 9 by 9 ft. for the top and 11 ft. 6 in. by 10 ft. for the bottom. These headings were to provide for the building of the north half of that portion of the center wall below the top of the bench-wall. Fig. 3 shows a cross-section of these headings, the section of wall, and the method of timbering. Work in these drifts advanced to about Station 156, where it was discontinued, temporarily, owing to the settlement of the foundation piers of the Union Depot Company's viaduct, which carries three tracks, crossing the line of the tunnel just west of Station 156. These drifts were carried east from Shaft No. 2, the top, middle, and bottom center drifts to provide for the building of the full section of the center wall. Fig. 3 also shows a general cross-section of these drifts, the method of timbering, and a cross-section of the wall. The timber bents were 2 ft. from center to center, and the clay at the sides was retained by 2-in. wooden sheeting placed horizontally outside of the bents. As stated, excavation for the entire center wall from Station 144 + 50 to Shaft No. 1 was made in this manner, and the portion east of Station 154 + 26, except the first drifts west from Shaft No. 1, was done under compressed air. From Station 154 + 26 to Station 155 + 16, where the ground was especially soft, owing to the proximity of one of the test-pits which had stood full of water for some time, a pressure of 17 lb. was required. East of this, to Shaft No. 1, the work was under a pressure of about 7 lb. Before any work was done under the Union Depot Company's viaduct, that structure was supported temporarily on concrete piers sunk below the bottom of the tunnel. This work was done by the contractor, and will be described later.

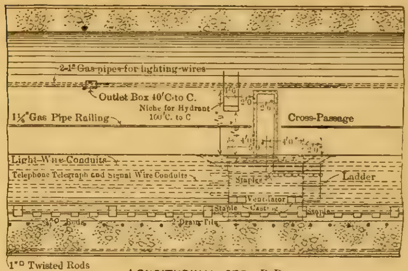
Previous to the installation of the side shields, the section of the east-bound tunnel between Stations 144 + 50 and 146 + 20 had been built in drifts, the general scheme being as outlined on Fig. 3.



LONGITUDINAL SEC. *A-A*



STA. 185+43 TO STA. 186+22



LONGITUDINAL SEC. *B-B*

General notes:

All exposed corners and edges of concrete to be rounded to 1" radius unless otherwise specified.

Outlet boxes for lighting to be 40' apart on each side of each tunnel, staggered.

Ladders to be 50' apart on each side of each tunnel staggered.

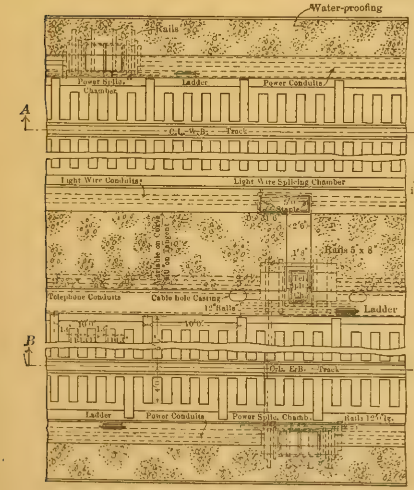
Splicing chambers to be 400' apart and cross-passages 200' apart.

Dimensions marked (x) vary for high tie and are *D* x 1" less than same dimensions for low tie when *D*=degree of curvature of track.

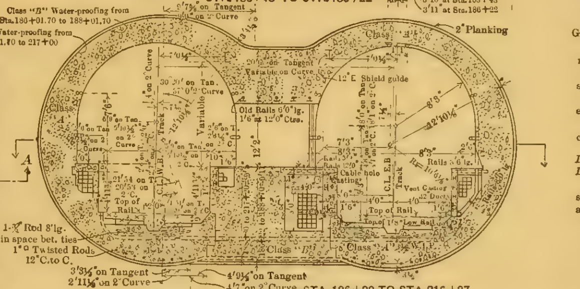
There are 40 telephone ducts from telephone splicing chamber at Sta. 186+15 to Windsor Shaft and 32 from Windsor Shaft to Windsor Portal.

TABLE OF CONCRETE PROPORTIONS

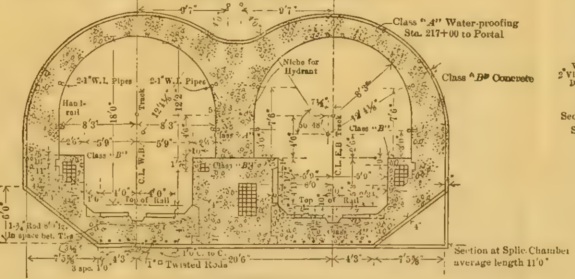
Class "*A*"-1 cement, 2 sand, 4 broken stone or gravel.
" "*B*"-1 " 3 " 6 " " " " "
" "*D*"-1 " 4 " 7½ " " " " "



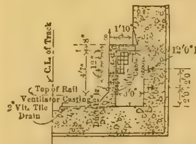
PLAN



STA. 186+22 TO STA. 216+87



STA. 216+87 TO WINDSOR PORTAL



Section through Power Splicing Chambers
Sta. 217+91 W.B. and Sta. 217+95 E.B.

DETROIT RIVER TUNNEL
DETAILS OF EASTERLY APPROACH TUNNEL

The east-bound shield was installed at Station 146 + 20 and the west-bound shield at Station 141 + 80, as before noted, and the excavation for the full tunnel section on either side of the center wall was made with the shields from these points down to Shaft No. 1.

At about the time that work was started west from Shaft No. 1, headings were also started east from the shaft toward the river. The full section of both tunnels, 2 ft. east from and adjoining the shaft, the north half of the center wall, below the top of the bench-wall, and a short piece of both east- and west-bound side-walls, up to the level of the bottom of the ducts, had been built when the work was temporarily abandoned on account of a change in the general method of handling it. It was originally intended that the westerly approach tunnel should be completed in drifts to the point of connection with the subaqueous tunnel. This, however, was found impracticable without the aid of compressed air, on account of the marked tendency of the clay to flow. At that particular time the contractor did not contemplate using compressed air on any part of the work in Detroit, but had decided to complete the section of tunnel from Shaft No. 1 to the connection with the subaqueous tunnel in the open by a coffer-dam.

The clay in the drifts and back of the shields was taken out by hand, with the aid of a semicircular knife, loaded into narrow-gauge cars, and cable-hauled to the shaft, where it was elevated to the surface and dumped on standard-gauge flat-cars. The semicircular knife was also used in the open-trench excavation. For such work it was drawn by a cable from a hoisting engine, and was easily guided by one man. The material from the trenches was loaded in skips and hoisted by derricks to flat-cars.

In the drifts the usual rate of progress of excavation for 24 hours, under normal conditions, was about 12 ft. The average rate of advancement of the side shields for working days was about 10 ft. per day of 24 hours.

The average cost of excavation in the drifts, where the clay was fairly stiff, was $2.37 per cu. yd. Under compressed air in the drifts, the average cost was $3.50 per cu. yd.; with the shields, it was about $4.90 per cu. yd. These figures include the cost of timbering, depreciation of plant, and distributive share of general expense.

Shields.—A description of the side shields, the method of timbering back of the shields, and the water-proofing is given here, as the general methods were the same on each side of the river. The side shields for Detroit and Windsor were of the same design, but of slightly different dimensions, to conform to the design of the tunnel sections, as shown by Figs. 4 and 5. The shields were large enough to include a ring of timbering 10 in. thick outside of the concrete section. Fig. 4 shows the plan of the Windsor shield, and Fig. 5 is a sketch in perspective of the shield and center wall, showing the timbering for the center wall excavation and that back of the shield. The shields were 13 ft. over all. The outside shell was of ¾-in. steel plate, strongly reinforced with angle-irons. The horizontal and vertical reinforcement was arranged so as to leave six pockets from which to remove the clay. The main body of the shield was 7 ft. 6 in. long, with a heavily reinforced cutting edge, to which was attached a tail-plate of ½-in. steel plate, 4 ft. 2 in. long. The tail-plate was not reinforced, its only duty being to hold the clay until the timbering could be placed. Each shield was supplied with twenty-one 5-in. hydraulic jacks, capable of expanding 20 in. The jacks were designed to be used at a pressure of 5 000 lb. per sq. in. and, in actual practice, were used up to 8 000 lb. Later, the two bottom jacks were replaced by two 8-in. jacks, and an extra 5-in. jack was added next to the center wall at the top. The shield traveled along the center wall, bearing against the channel irons, as shown in Fig. 5.

A temporary floor or working platform was built behind the shield, at the level of the top of the bench-wall, and carried a track for handling the material, the excavated material being loaded on cars by a mechanical conveyor operated by compressed air.

The clay was cut, as before noted, with semicircular knives, pulled by two men and guided by a third. The excavation was carried about 2 ft. ahead of the shield over practically the full tunnel section, and the shield was shoved forward the 2 ft. by the hydraulic jacks, bearing against the timbers already placed. The timbering consisted of pieces 4 ft. long, 10 in. deep, and of variable widths, cut to segments of a circle, and placed as shown in Fig. 5. When the shield was shoved ahead, the timbers (or cants, as they were called) were placed inside the tail-piece, as many rings being placed at each move as were required to fill in the distance covered by the advance of the shield. The cants in each ring were placed so as to break joints with those in the preceding ring. Each ring was expanded to the full radius against the tail-piece by wedges forced between several of the butting cants by the jacks.

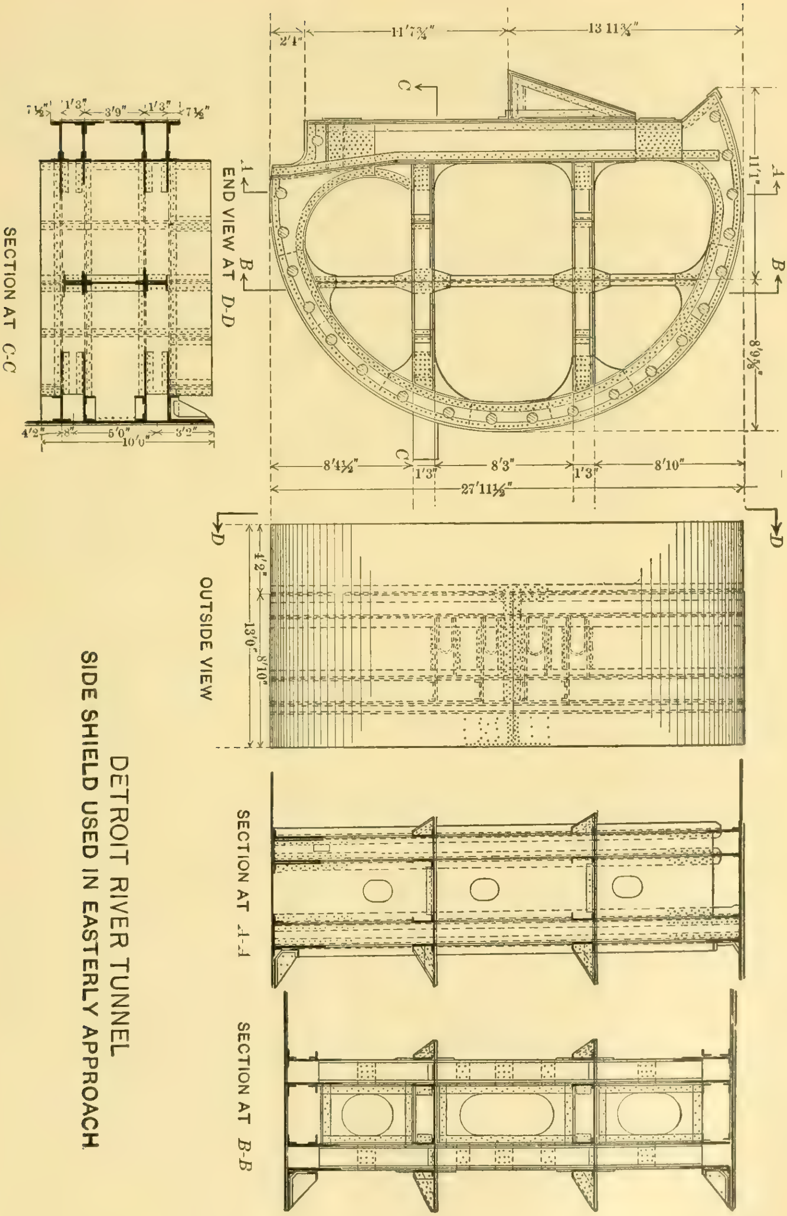


FIG. 4.

DETROIT RIVER TUNNEL
SIDE SHIELD USED IN EASTERLY APPROACH.

There was very little trouble in keeping the shields on line, but they were off grade frequently. The variation from true grade amounted at times to 6 in., and seemed to occur at intervals, regardless of the care exercised in operating the shields. The irregularity in the grade line followed was due, in no case, to a variation in the character of the material encountered. The shields were never quickly brought back to true grade line when once started on a downward or upward path. This tendency is natural enough with any shield, but it was probably aggravated on this work owing to the design of the shield, which obviously was not as rigid as one with a cutting edge describing a full circle or ellipse, with jacks on all sides.

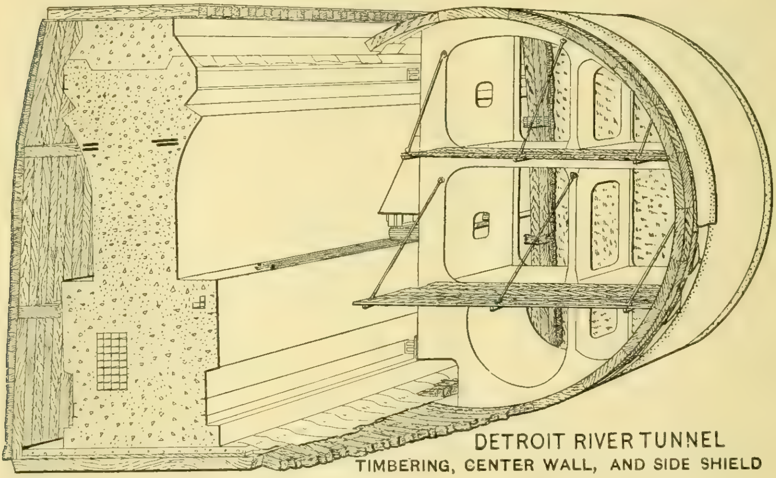


Fig. 5.

Views of work with the shield in the approach tunnel are shown on Plate CXII.

Water-proofing.—The water-proofing in the approach tunnels consists of alternate layers of felt and coal-tar pitch. There were three classes of water-proofing, made up as follows: (A) three layers of felt and four of pitch; (B) five layers of felt and six of pitch; and (C) ten layers of felt and eleven of pitch.

Two general methods were used in making the laps between the successive layers of felt and the successive sections of the water-proof sheet, as follows: (1) Where it was possible, the successive layers of felt were laid so that the vertical or transverse edge, as the case might

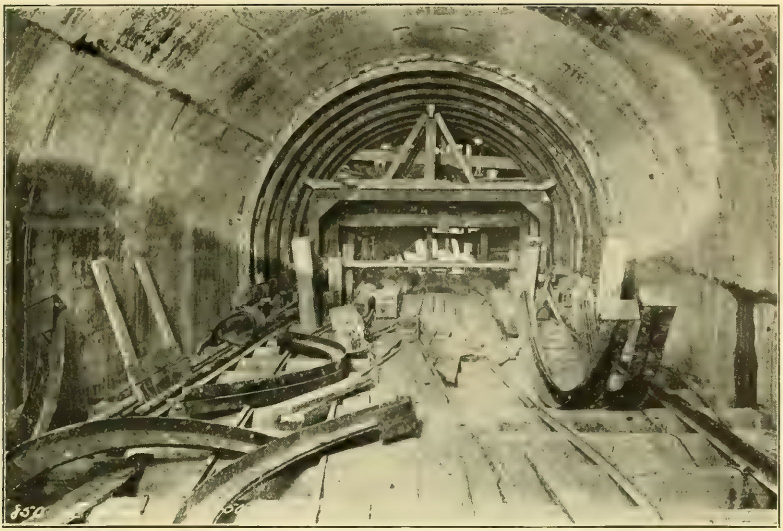


FIG. 1.—INTERIOR OF APPROACH TUNNEL. ARCH FORM IN POSITION.

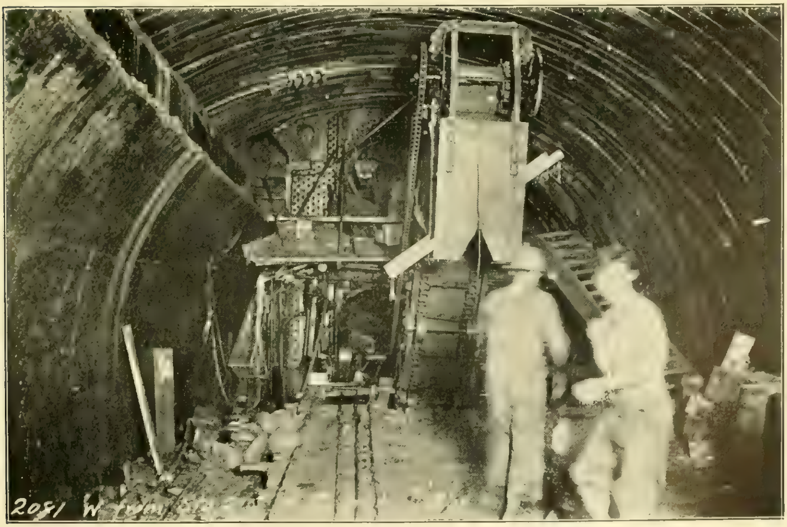


FIG. 2.—SIDE SHIELD IN OPERATION.

be, of each strip of felt would step forward one-third the width of the preceding strip, or one-fifth or one-tenth, according to the number of layers. (2) The water-proofing was applied in three, five, or ten successive layers, with a 3-in. lap between the strips of felt, breaking joints between layers. It was necessary to use this method with the ten-ply water-proofing, when the working space was limited, and there was not room to continue the first method of lapping for any considerable distance, where, for instance, the concrete followed the water-proofing up to the limits of the space excavated.

One method would probably have been as effective as the other under favorable conditions, but it was found that back of the shields, where high temperatures obtained, due to the setting of the concrete, and especially under compressed air, it was difficult to hold the water-proofing in place on the sides and roof of the tunnel, and prevent the felt from sagging, without nailing at least three layers to the timbers. With the first method, three layers, or as many as desired, could be nailed soon after the first felt had been applied. With the five-ply, three layers were nailed to the timbers. The objection to the second method was, that, under high temperatures, the first layers placed sagged considerably before the nails could be driven. Tests were made in an effort to hold the water-proofing by nailing only the first layer, so that the nail-heads would be covered by at least two layers of felt. Where there was not much heat, this method worked very well, particularly where the first layer was of burlap. Under high temperatures, however, it was necessary, as stated, to drive nails through the three layers and rely on a coating of pitch over the nail-heads. If there were any weak places, they did not appear during the progress of the work, and were not expected to be noticeable where the work was under compressed air. As a reinforcement to the nailing process, a strip of tin was used, which followed the edge of each strip of the outer layer of felt, thus giving continuous support to the felt and acting as a washer for the nails.

From the invert upward and over the arch, the water-proofing was carried in three lifts, corresponding to the lifts of concrete. Where there were only three layers of paper, the horizontal joint between two lifts was made by a 12-in. lap of the sheet of three layers of the upper lift over the outside of those of the lower; where there were five thicknesses, three of the upper lifts lapped 12 in. outside those of the lower and two inside. With ten thicknesses, the bottom lift was separated sufficiently for a 12-in. lap with two sheets of five layers each; four layers of the upper lift lapped 12 in. over the outside of the lower, the next three layers being inserted between the two sheets of the lower, and the inside three lapped inside. This latter arrangement is assuming the water-proofing to have been placed on the forms in advance of the concrete. If laid on the concrete, as in the open trenches, the words "inside" and "outside" should be interchanged. The vertical, or transverse, joints between successive sections of the water-proof sheet along the tunnel were made as by the first method, or as described for horizontal joints, depending on the conditions.

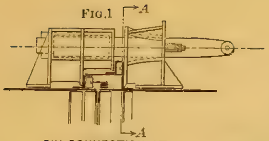
There was some difficulty in making the lap between old and new water-proofing where considerable time had elapsed between the placing of the first and last, owing to the felt having become water-soaked and more or less rotten. This trouble was overcome to a great extent by using burlap for the lap in place of the felt in the first water-proof sheet and soaking the burlap in creosote. There was also some trouble at first from the water-proofing on the center wall, placed in the drifts, being torn by the edge of the shield as it passed. On the portion of the wall built after the shields were started this trouble was eliminated by rolling up the loose edge of the water-proofing on the center wall and protecting it by a covering of boards.

The coal-tar pitch was used at a temperature of not less than 250° Fahr. If the surface on which the pitch was to be applied was damp, and it was not practicable to dry it, an extra layer of felt was used.

Concrete.—In the approach tunnels the concrete was placed in lifts, as shown by Fig. 6, which represents the shield section, but shows in general how the concrete was carried up throughout the approach tunnels. The standard length of run was 12 ft., and the concrete in each run was allowed to set sufficiently for the form to be moved before the succeeding run was made.

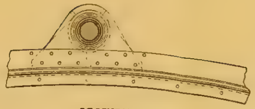
In the westerly approach, the concrete for the center wall, up to the joint just below the top water-proofing, was deposited from dump-cars run along the top drift. The concrete above this, except on the work under compressed air, was deposited from the ground surface above through chute holes, 12 in. in diameter, at intervals of about

FIG.1

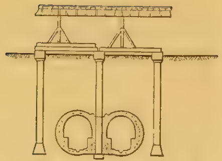


PIN CONNECTION AT TUBE SPLICE.

FIG.2



SECTION *A-A*



SUPPORTS FOR RIVER ST. VIADUCT.

FIG.3

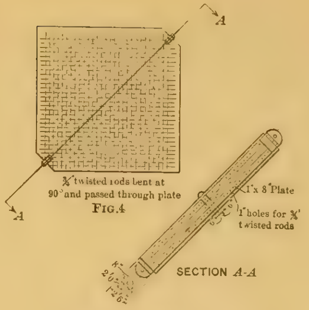
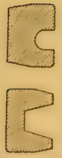

A
A
¾″ twisted rods bent at 90° and passed through plate
1″x 8″ Plate
1″ holes for ¾″ twisted rods
8″
2′0″
1′2½″

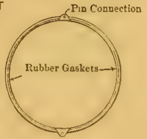
FIG.4

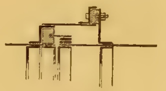
SECTION *A-A*

CONCRETE ANCHOR



RUBBER GASKETS





JOINT AS MADE BY DIVER

FIG.5

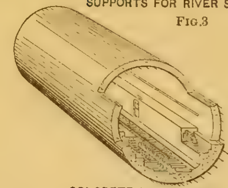
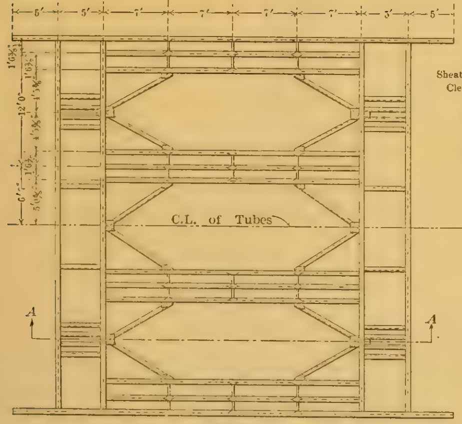
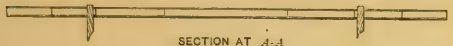


FIG.6

CONCRETE LINING INSIDE TUBES

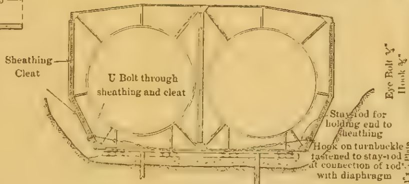


PLAN



SECTION AT *A-A*

FIG.7


Sheathing Cleat
U Bolt through sheathing and cleat
Stay-rod for holding end to sheathing
Hook on turnbuckle fastened to stay-rod at connection of rod with diaphragm

METHOD OF ANCHORING END OF TUBE SECTION TO GRILLAGE.
NATURE OF DIAPHRAGM.

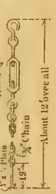
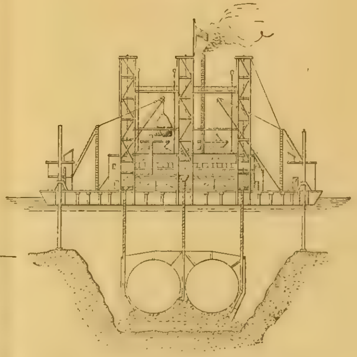


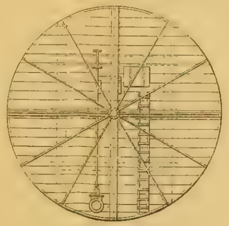
FIG.8

SKETCH OF TURNBUCKLE ARRANGEMENT



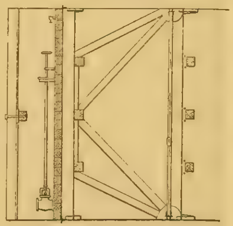
METHOD OF PLACING CONCRETE BY TREMIE.

FIG.10



END VIEW OF BULKHEAD

FIG.9



LONGITUDINAL SECTION ON C.L.

DETROIT RIVER TUNNEL.
DETAILS OF CONSTRUCTION.

12 ft. The top drift, for the work under compressed air, was made higher than for the work in normal atmosphere, so that the concrete for the entire wall could be delivered in cars. Chute holes, 12 in. in diameter, were also provided at intervals of 12 ft. over both the east- and west-bound tunnels in the westerly approach, for depositing concrete for the invert, side-wall, and arch, back of the shield.

In the approach tunnels, two classes of concrete were used: 1:2:4 and 1:3:6. The first constituted the main body of the tunnel, the latter being used only over the ducts in the bench-walls and outside of the water-proofing, as a protection course. It was omitted back of the shields, where the water-proofing was applied on the timbering. Still another grade, not indicated on the plans, was used at the connection of the westerly approach with the subaqueous tunnel, outside of the water-proofing, to insure a water-tight connection. This consisted of one part of cement, one of sand, and two of gravel. The gravel for all concrete used in the tunnel was taken from the Black

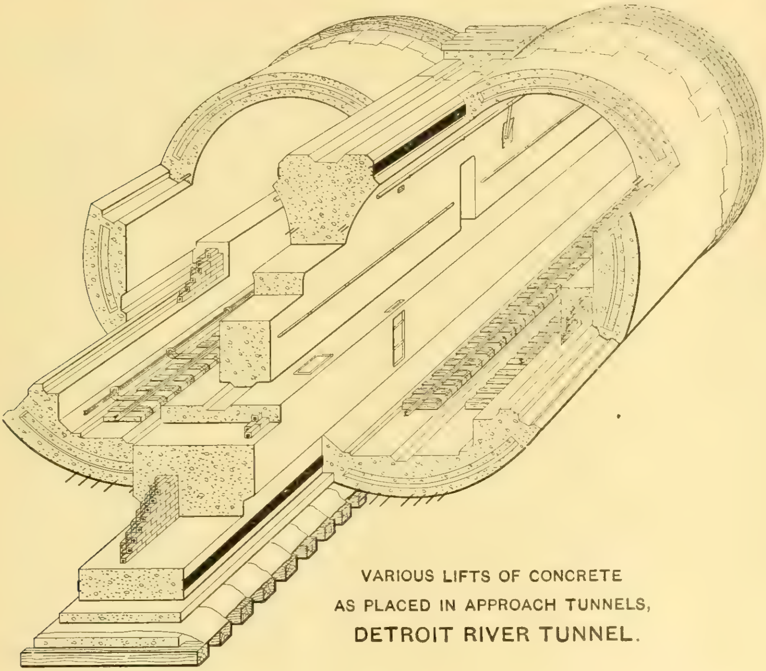

VARIOUS LIFTS OF CONCRETE
AS PLACED IN APPROACH TUNNELS,
DETROIT RIVER TUNNEL.

Fig. 6.

River, at Port Huron, Mich., by "sand suckers," these boats making direct delivery for storage or immediate use. The gravel was screened on the work, thus giving the proper proportions of clean sand and gravel.

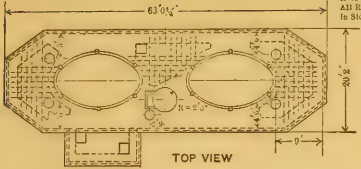
The forms for the concrete on the approaches consisted of steel or wooden ribs, with 2-in. wooden lagging covered by heavy sheet iron to give a uniformly smooth surface.

Maintenance of Structures.—As has been stated, the tunnel lies wholly within the Railroad Company's right of way, and, in Detroit, the open cut and 1 258 ft. of the tunnel are parallel with, and immediately adjoining, the northerly right-of-way line. On account of the limited width of the right of way along this part of the work, and the necessity for retaining as many tracks in service as possible, the first track south of the open cut—the west-bound passenger track—was supported on piles. The pile support was continued under this track to Station 145 + 00, along the open-trench work.

Along the northerly right-of-way line are the abutments of three bridges, carrying Howard Street, Lafayette Avenue, and Twelfth Street, over the Michigan Central Company's tracks. These abutments settled from 8 to 12 in., but no serious damage resulted. There is also a large five-story brick building on the northerly right-of-way line, east of Layafette Avenue, along which steel sheet-piling was driven to the level of the bottom of the tunnel, hoping to guard against settlement. The building settled, however, about 6 in. on the side next to the tunnel and ½ in. on the opposite side, 100 ft. back of the right of way. On the opposite, or south, side of the right of way, 40 ft. south of the tunnel, a large eight-story building showed no settlement. This building was constructed while the tunnel work was in progress, before excavation with the side shields had been made, and the foundation was carried down to within 7 ft., approximately, of the grade of the bottom of the tunnel. The south abutment of the Fort Street Bridge, which is 25 ft. south of the tunnel, settled 12 in., but caused no serious damage.

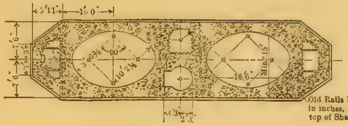
The viaduct of the Fort Street Union Depot Association, previously referred to, which crosses the line of the tunnel near Station 156, was carried over the tunnel, temporarily, by six concrete piers, three under each side of the viaduct, which the contractor sank to a depth below the bottom of the tunnel, as shown by Fig. 3, Plate

PLATE CXIV.
PAPERS, AM. SOC. C. E.
AUGUST, 1911.
KINNEAR ON
THE DETROIT RIVER TUNNEL.



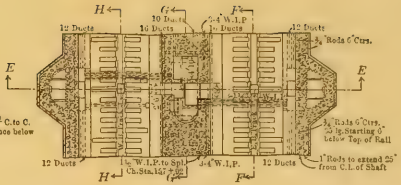
Reinforcement in Concrete Covers to be 1″dia. Rods, Spaced 12″apart All Rods are to be embedded 1 foot in Side-walls.

TOP VIEW



Old Rails 18′0″lg. spaced $\frac{500}{h}$ C. to C. in inches, where h = distance below top of Shaft, in feet.

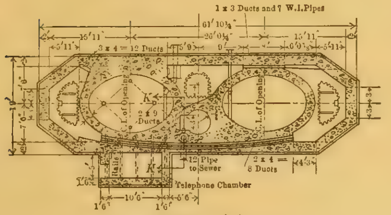
SECTION *B-B*



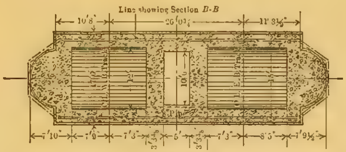
H
G
F
E
E
12 Ducts
10 Ducts
16 Ducts
3-4″W.I.P.
16 Ducts
12 Ducts
¾″ Rods 6″Ctrs.
¾″ Rods 6″Ctrs. 25′ lg. Starting 6′ below Top of Rail
12 Ducts
1½″W.I.P. to Spl. Ch. Sta. 157 + 92
3-4″W.I.P.
12 Ducts
1″ Rods to extend 25′ from C. L. of Shaft
H
G
F

SECTION *C-C*

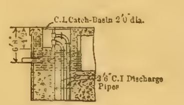
DETROIT RIVER TUNNEL.
DETAILS OF DETROIT SHAFT



SECTION *A-A*



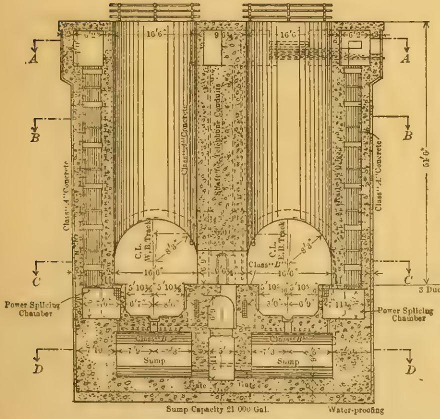
SECTION *D D*



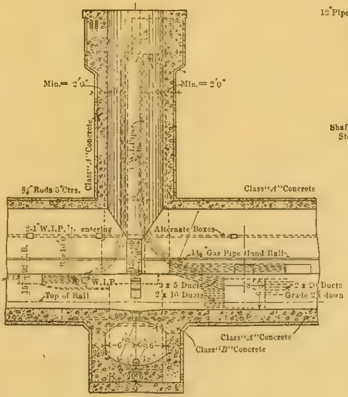
SECTION *K-K*

TABLE OF CONCRETE PROPORTIONS
Class "*A*" 1 Cement, 2 Sand, 4 Broken Stone or Gravel
Class "*B*" 1 " 3 " 6 " " " "

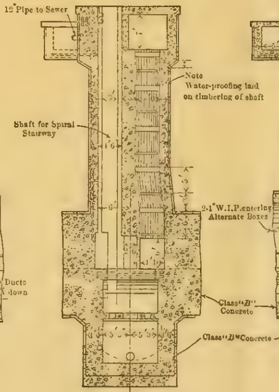
General Notes
All exposed corners and edges of concrete to be rounded to 1″ radius unless otherwise specified.
Spiral Stairway furnished and placed under another contract.
Use Class "*A*" water-proofing above water level.
Class "*B*" between water level and track level Class "*C*" below track level.
All stationing W.B. except where noted.



SECTION AT C.L. OF SHAFT

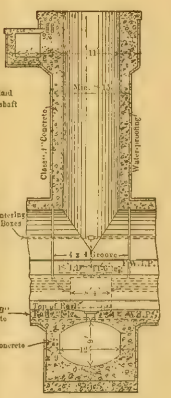


SECTION *F-F*

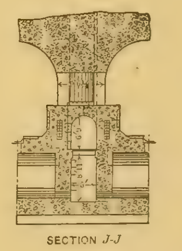


12″ Pipe to Sewer
Note
Water-proofing laid on timbering of shaft
Shaft for Spiral Stairway
2-1″ W.I.P. entering Alternate Boxes
Class "*B*" Concrete
Class "*B*" Concrete

SECTION *G-G*



SECTION *H-H*



SECTION *J-J*

CXIII. These piers settled a maximum of 0.3 ft. The concrete wall of the tunnel, which encloses the lower part of two of the piers, settled 0.1 ft. with these piers. The columns of the viaduct, which rested on 24-in. I-beams carried by the piers, were jacked up from time to time, thus maintaining the grade of the viaduct.

A 42-in. water main in River Street, on which street the above-mentioned viaduct is located, was temporarily supported by steel hangers swung from the viaduct.

A double 5-ft. sewer, crossing the line of the tunnel at River Street at a very flat angle, was temporarily replaced by a steel tube and afterward rebuilt of reinforced concrete.

At Twelfth Street a 5-ft. single brick sewer, was temporarily replaced by a steel pipe. Part of the tunnel at this point was built in open trenches or cut and cover, the pipe being carried by trusses over the trenches.

The settlement of the tracks over the tunnel was not very great; it was gradual, and was taken care of from time to time by re-ballasting.

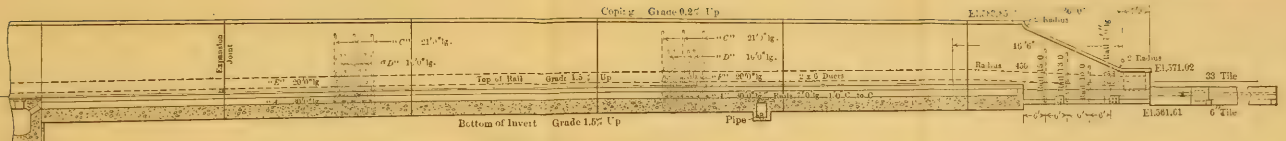
Easterly Approach Tunnel.

The easterly approach tunnel extends from Station 220 + 58 to Station 185 + 43. It was originally intended that the limits should be between Stations 217 + 06 and 185 + 00, but, after the work in the initial drifts had been in progress for some time, the character of the clay, as disclosed near the upper end, was such that it was decided to extend the tunnel section farther east than first proposed. Experience in the headings near the river showed that it would be better, on account of the softness of the clay, not to carry the headings farther west than Station 185 + 43, and to make the connection with the subaqueous tunnel at that point.

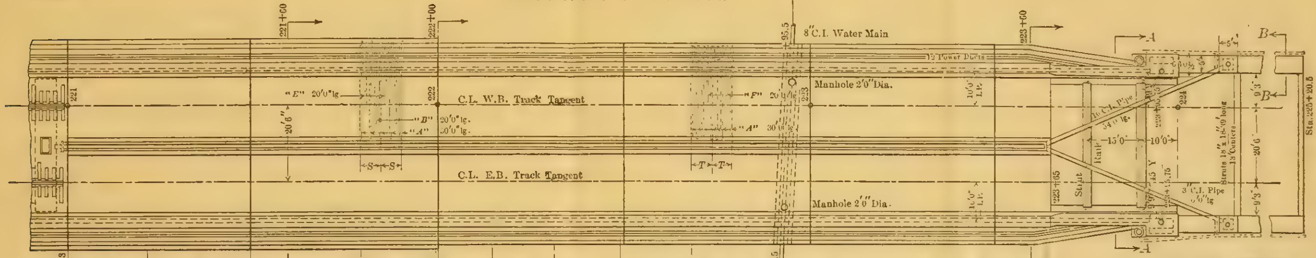
Work on the easterly approach tunnel was conducted at first from two shafts, one, the proposed permanent shaft, 20 by 60 ft., including both tunnels; the other, a temporary working shaft, just large enough to enclose the center-wall headings. Subsequently, two other temporary shafts were sunk, similar to the first. The proposed permanent shaft, known as No. 1, was located at Station 185 + 93, and the temporary shafts, known as Nos. 2, 3, and 4, at Stations 192 + 97, 203 + 50, and 216 + 80, respectively. The construction of the easterly approach tunnel involved 196 700 cu. yd. of excavation and 65 200 cu. yd. of concrete.

Excavation.—The first excavation for the easterly approach, started in the fall of 1906, was in a single heading east from the proposed permanent shaft and in the corresponding heading west from Shaft No. 2 to meet that from Shaft No. 1. This opening was just large enough to include the north half of that portion of the center wall below the top of the bench. To provide for the handling of concrete for this part of the wall, another small drift was put through between the two shafts over the first drift and the completed section of wall. This portion of the wall was built before excavating was begun for its south half, because of the great pressure from the clay and the danger of collapse of the drifts, in case too large openings were made simultaneously. Later, the bottom drift for the south half of the center wall, called the south bottom center drift, was put through and the concrete was placed up to about the level of the top of rail. Great difficulty was experienced in this drift on account of the side pressure and the swelling of the clay from the face and roof. It seemed at times as though the drift would have to be abandoned. There was also a slight movement of the north half of the wall already built, as this drift was opened up, and a large settlement crack, parallel to the drift, appeared in the ground surface, attended by a settlement on top of from 1 to 2 ft.

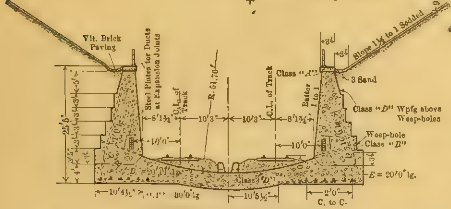
At about the same time that work was being carried west from Shaft No. 2, the bottom center drift was also being carried east from this shaft. This was a double drift for the full width of the center wall. (It will be noted that the center wall becomes narrower toward the east, owing to the divergence of the center lines of the tunnels, from 26 ft. 4 in. at the river to 20 ft. 4 in. at Station 197 + 37, the point of tangent.) Excavation for the bottom center drift was also pushed from Shafts Nos. 3 and 4 as soon as they were built, which was early in 1907. Excavation was started for the middle center drift east from Shaft No. 2, but had to be abandoned, as the clay came in faster than the timbers could be placed. The middle center drift, west from Shaft No. 2, was also started—over the south bottom center drift—but likewise had to be abandoned. Cross-sections of these drifts were practically the same as those shown by Fig. 3 for the westerly approach tunnel. The timber bents in these drifts, however, were about 12 in. from center to center.



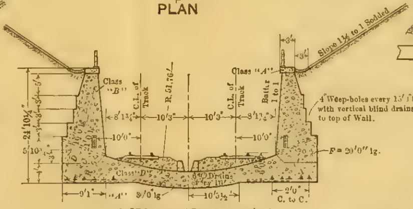
CROSS-SECTION ON C.L. BET. TRACKS



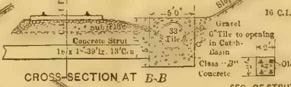
PLAN



CROSS-SECTION AT STA. 221+60

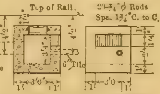


CROSS-SECTION AT STA. 222+00

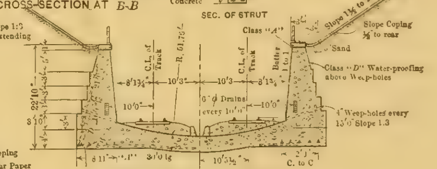


CROSS-SECTION AT B-B

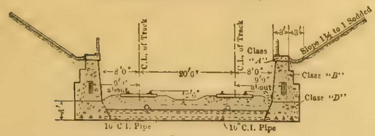
SEC. OF STRUT



DETAILS OF CATCH-BASIN

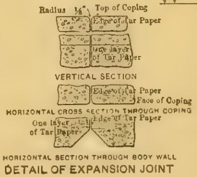


CROSS-SECTION AT STA. 223+60



SECTION A-A

Notes:
All exposed edges and corners of concrete to be rounded to 1" Radius
Expansion Joints to be spaced 50' C. to C. with tar paper joints.
Water-proofing on back of wall to be (Class "D") one coat of straight run coal-tar pitch ⅛" thick above Weep-holes
Track Rail 6" high 100 # per yd.
Rails in bottom of walls to break joints and to be lapped 3'0"
All Stations refer to W. B. Track.
All reinforcing rods 1" dia. round rods except 30' lengths which are ⅞" twisted rods
Back-fill for 18" back of wall to consist of cinders or other porous material from top of wall to Weep-holes



VERTICAL SECTION

HORIZONTAL CROSS SECTION THROUGH COPING

HORIZONTAL SECTION THROUGH BODY WALL

DETAIL OF EXPANSION JOINT

DETROIT RIVER TUNNEL
DETAILS OF EASTERLY OPEN CUT

No. 2 under compressed air. For the work near Shaft No. 1, a material shaft, 5 ft. in diameter, with a material lock at the top, 13 ft. in diameter, was built just west of the old shaft. The new shaft was sunk on the center line of the center wall. For the work west of Shaft No. 2, a material and man lock was placed in the drifts just west of the shaft. An engineers' shaft, 3 ft. in diameter, with a lock at the top, was sunk about 12 ft. east of the old shaft, over the east-bound tunnel. It was several months after the work between Shafts Nos. 1 and 2 was placed under compressed air that the center shield was abandoned, and the center drifts east of Shaft No. 2 were similarly treated.

The excavation for the full tunnel section on either side of the completed center wall, from Shaft No. 4 down to Station 186 + 23, 30 ft. east of old Shaft No. 1, was made with the side shields. An attempt was made to operate these shields without compressed air, but was found to be impracticable. The clay flowed in at the face of the shields, just as it had in the drifts, and air-locks were placed about 200 ft. west of Shaft No. 4. All work thereafter was done under compressed air, the pressure required ranging from 10 to 20 lb., the higher pressures being near the river.

The tunnel section east of Shaft No. 4, known as the approach tunnel extension, was built by cut-and-cover methods, except a portion of the center wall below the top of the bench-wall, which was first built in drifts to provide a means of bracing the trenches.

A new permanent shaft was located and built at Station 187 + 68, which provides an opening over each tunnel. This shaft is substantially of the same design as the Detroit shaft, details of which are shown on Plate CXIV.

The rate of progress of excavation at Windsor, with the shields and in the drifts, under favorable conditions, was about the same as at Detroit, being approximately 10 ft. per day of 24 hours with the shields and 12 ft. per day in the drifts. The maximum distance covered by one of the shields in a single day was 19 ft. 10 in.

The cost of excavating in drifts without compressed air averaged about $2.40 per cu. yd. under favorable conditions; with compressed air, the cost was about $3.50 per cu. yd., except for the work near old Shaft No. 1, where the cost ran as high as $16 per cu. yd. With the shields the fair average cost was $4.90 per cu. yd. These costs

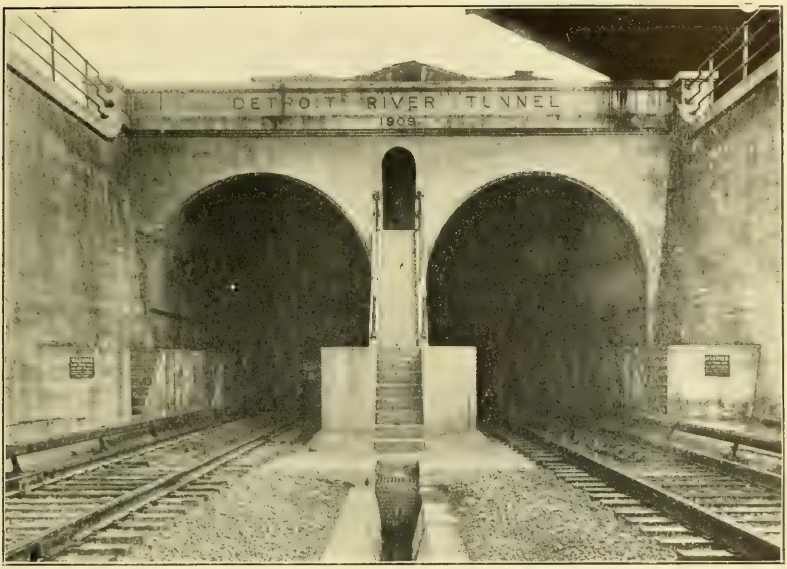


FIG. 1.—WESTERLY OPEN CUT, DETROIT RIVER TUNNEL.

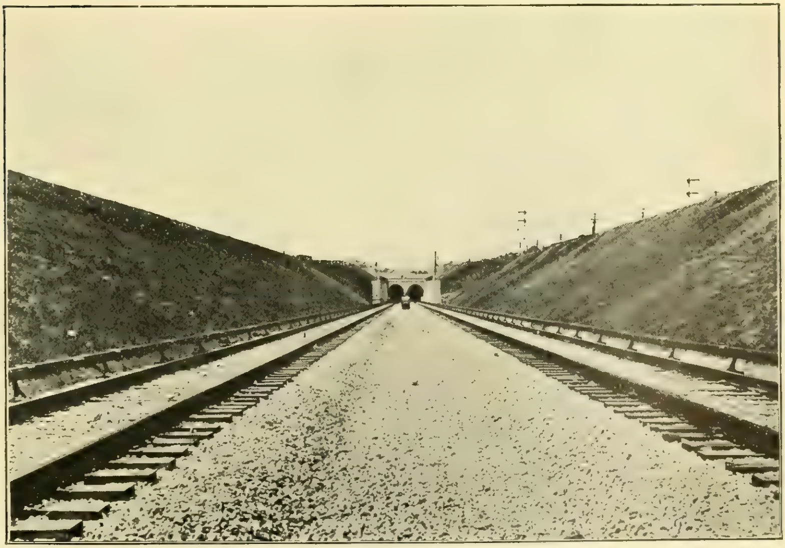


FIG. 2.—EASTERLY OPEN CUT, DETROIT RIVER TUNNEL.

include timbering, compressed air, and incidentals. The cost of the compressor plant for supplying air to two side-shield headings and two center-wall headings was a trifle more than $80 per day.

Concrete.—In the easterly approach tunnel the concrete was placed in the same manner as for the westerly approach, except that all concrete was delivered in dump-cars in the tunnel. Arches were filled by shoveling the concrete into the form from the end, as the form for a 12-ft. section was set up complete before concreting was started. Concrete for the center wall, back of the center shield, was delivered in cars up to a level just below the water-proofing course, and above that through chute holes put down from the surface at intervals of about 30 ft. All concrete for the portion of the center wall built under compressed air was delivered in the drifts in cars, as previously stated. The average cost of the 1 : 2 : 4 concrete was about $8.25 per cu. yd. in the side-shield headings, and a little more than $6 per cu. yd. in the center wall, where it was deposited through chutes; in the drifts, under compressed air, the cost was about $10.70 per cu. yd.

The work of water-proofing and timbering was similar to that for the Detroit approach.

Easterly Open Cut.

The easterly open cut extends from Station 220 + 58 to Station 250 + 00. The gradient, as noted, is 1.5%, and the maximum depth of cut at the portal of the tunnel is about 45 ft. From the portal, east to Station 224 + 00, the slopes are retained by walls which have a maximum height of 25 ft. at the portal. The tops of the walls are very nearly level, and are about 15 ft. below the original ground surface at the east end. The height and extent of the walls were governed by the width of the right of way north of the cut, on which the present main tracks are located. As will be noted by the location map, the tunnel tangent is not parallel to the northerly right-of-way line, and is nearest to it at the portal. The 1½ : 1 slope was calculated for the sides of the cut, and on this basis it was found necessary, in order to provide sufficient width of right of way for two tracks at the narrowest point, to carry the walls to Station 224 + 00. A cross-section of the walls and cut near the portal is shown on Plate CXV. Views of the finished open cuts at the portals are shown on Plate CXVI.

As stated elsewhere, the building of the open cut destroyed the Railroad Company's large yard at Windsor. Additional property was acquired immediately, and a modern yard, complete in every detail, is now in operation.

Excavation.—The total excavation for the open cut, which was made by a steam shovel, was 240 000 cu. yd. The slopes were finished by hand, and sodded.

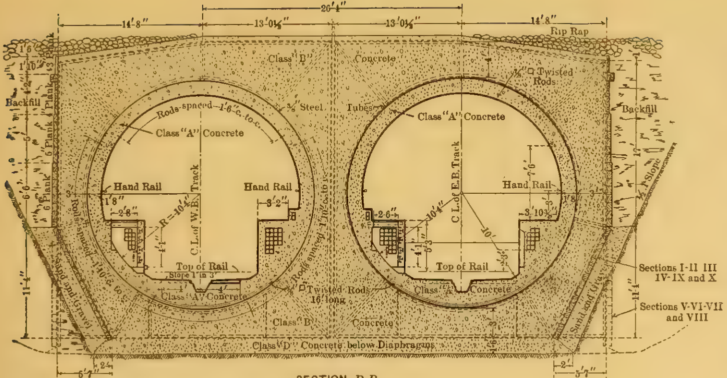
Concrete.—The walls are of concrete, of the same proportions and placed in the same manner as for the westerly open cut. The general design of the walls and details is also the same as for the westerly open cut.

The average cost for the 1 : 3 : 6 concrete in the retaining walls for the easterly and westerly open cuts was about $4.75 per cu. yd. The average cost for excavation in the easterly open cut was 32 cents per cu. yd., including the cost of the plant and incidental expenses, but not including the cost of disposing of the material, beyond loading it on cars and delivering them at the top of the grade, from which point they were handled by the Tunnel Company. The excavation in the westerly open cut cost about $1.40 per cu. yd., the higher cost there being due to more difficult working conditions, owing to its proximity to tracks and structures.

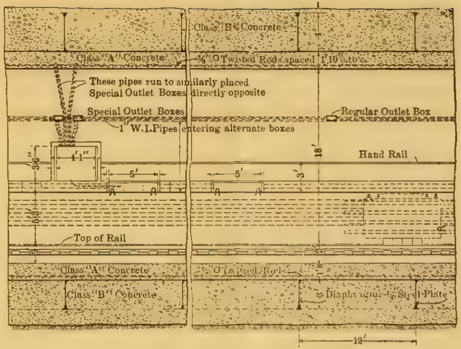
Drainage.—Provision has been made for taking care of most of the surface-water that will naturally drain into the cut, and of the drainage from the subway at Tecumseh Road, east of Windsor, through a sewer, the inlet of which is just below the bottom of the cut at Station 236 + 00, with an outlet at the river. This sewer was built by the Tunnel Company, and is 24 in. in diameter from the catch-basin to a point over the portal of the tunnel, where it increases to 36 in. Blind drains are provided at the back of the walls. The general drainage system for the tunnel is described later.

Subaqueous Tunnel.

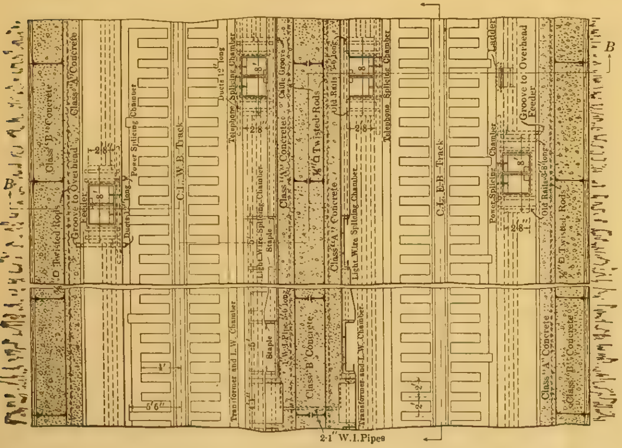
The subaqueous section of the tunnel, as previously noted, is 2 668 ft. long, extending from Station 158 + 75 to Station 185 + 43. It will be seen by the plans that about 1 000 ft. of this section is level; that the vertical curves connecting the level with the grades of the approaches fall within this section almost entirely; and that both the easterly and westerly ends are on curves. The methods used in constructing this section were entirely new, as applied to subaqueous tunnels, and are particularly interesting, in view of the general success attained.



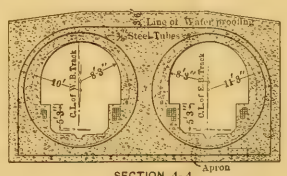
SECTION *B-B*



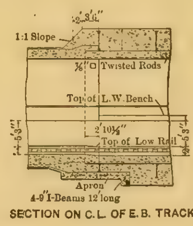
SECTION ON C.L. OF E.B. TRACK



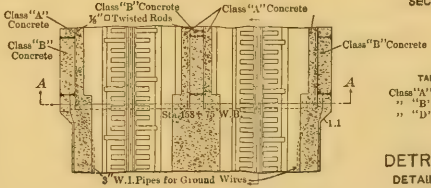
PLAN



SECTION *A-A*



SECTION ON C.L. OF E.B. TRACK



PLAN

CONNECTION BETWEEN DETROIT APPROACH AND SUBAQUEOUS TUNNEL

TABLE OF CONCRETE PROPORTIONS

Class "A" = 1 Cement, 2 Sand, 4 Broken Stone.
" "B" = 1 " 3 " 6 " "
" "D" = 1 " 4 " 7½ " "

DETROIT RIVER TUNNEL
DETAILS, SUBAQUEOUS TUNNEL

Design.—The plan, as adopted, consisted in dredging a trench of the required depth and width; sinking to correct position in the trench steel tubes in pairs, constructed so as to be water-tight; and surrounding the tubes with concrete, in plastic form, deposited in the water.

The surrounding, or exterior, concrete thus deposited, formed an artificial rock through which two water-proofed openings had been provided, and the inner lining, or tunnel proper, was built in normal atmosphere. The tubes, which were fitted at regular intervals with heavy wooden bulkheads and designed to stand the full hydrostatic pressure, were unwatered later, and lined with reinforced concrete, 20 in. thick. After the exterior concrete had been placed and before the tubes were unwatered, the remaining section of the trench on either side of the tunnel was back-filled with gravel and clay to the full height of the exterior concrete deposit.

The tubes are 23 ft. 4 in. in diameter, built of $\frac{3}{8}$-in. steel plates, riveted together and ship-caulked. They were sunk in pairs, 26 ft. from center to center, each for a single track, and in sections 262 ft. 6 in. long, with two exceptions, one section, containing the drainage sumps, being 238 ft. 6 in., and the closing section, connecting with the Windsor approach tunnel, 64 ft. 6 in. The tubes were reinforced with 4 by 4-in. circumferential stiffener angles riveted to the inside of the plate at intervals of 12 ft. To strengthen the tubes further during launching, sinking, and concreting, twelve steel rods, $\frac{7}{8}$-in. square, were placed at each stiffener angle, radiating from a cast-steel ring at the center of the tube to the angle. These rods were bolted to the angle at points corresponding to the hour marks of a clock, passed through corresponding holes in the ring, and were made rigid by turning up a nut on each rod inside the ring.

For convenience in depositing the exterior concrete, the tubes were fitted at intervals of 12 ft. with steel diaphragms, $\frac{1}{4}$-in. thick, to the upright edges of which was attached heavy wooden sheathing. A cross-section of the subaqueous tunnel is shown on Plate CXVII. The sheathing served to retain the freshly deposited concrete within defined limits, and, with the diaphragms, formed pockets, each of which could be filled from top to bottom, independently of the adjoining pockets, in from 6 to 8 hours, thus providing for practically a monolithic structure throughout. The sheathing consists of planking, 6 in. thick at the bottom of the diaphragm, diminishing to 3 in. at the top. It will be noted that the minimum thickness of the concrete outside the tubes is 3 ft. An 18-in. layer of gravel is shown below the bottom of the diaphragm, but for this was substituted a 1: 4: 8 mixture of concrete. The bottoms of the diaphragms are straight, thus giving the structure a level bearing on the foundation before the concrete was carried above the bottom of the diaphragms. The diaphragms on four sections of tubes are wider at the bottom than on the other sections, thus providing a greater bearing area, which was deemed advisable owing to the fact that the clay was slightly softer than that underlying the preceding and subsequent sections.

It has been stated that the entire tunnel was built through blue clay. Under the river the clay overlies limestone, which is about 90 ft. below the mean elevation of the water surface. The depth of trench varied from 60 to 80 ft. below the mean surface, and the average depth of the river bed along the line of the tunnel is 36 ft., the minimum being 18 and the maximum 48 ft. For a distance of several hundred feet near the middle of the river, the top of the tunnel is from 3 to 7 ft. above the bed of the river. Where the depth of the main river channel was originally 40 ft. deep or more, both the United States and Canadian Governments required that a depth of 40 ft. be maintained. The tunnel was built, leaving a depth of approximately 41 ft. in the main channel. Under the remainder of the river, the top of the tunnel is below the original bed of the river.

Work on this section of the tunnel was carried on at the same time as that on the approaches. The operations were conducted continuously from the point of connection with the Detroit approach to a connection with the Windsor approach.

Excavation.—The greater part of the excavation for the trench was made with a clam-shell bucket, having a capacity of 3 cu. yd. The bucket was swung by a steel cable from a 60-ft. steel boom, and was operated by a double-drum hoisting engine. The plant was installed on a large scow equipped with two 24 by 24-in. steel spuds, 86 ft. long, placed aft for anchoring. This dredge removed an average of 600 cu. yd. of clay per day of 10 hours; the maximum quantity taken out in one day was 1 400 cu. yd., and the maximum for one month was 25 000 cu. yd., place measurement. The clam-shell is shown in Fig. 1, Plate CXVIII.

It was thought at first that the work might be done by a dipper

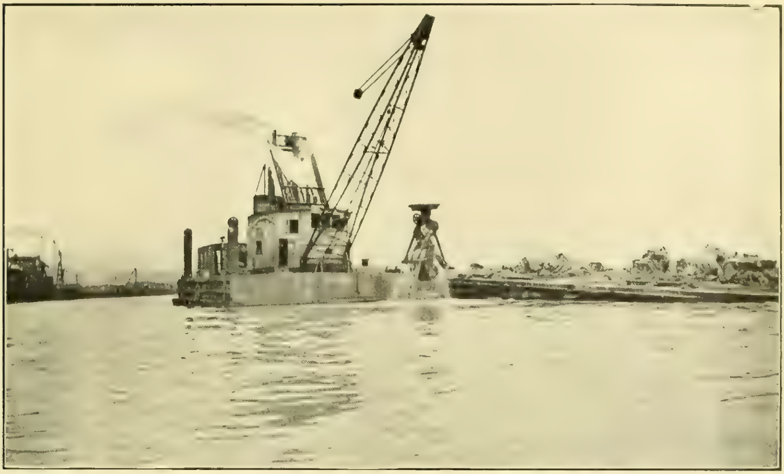


FIG. 1.—CLAM-SHELL DREDGE USED ON DETROIT RIVER TUNNEL.

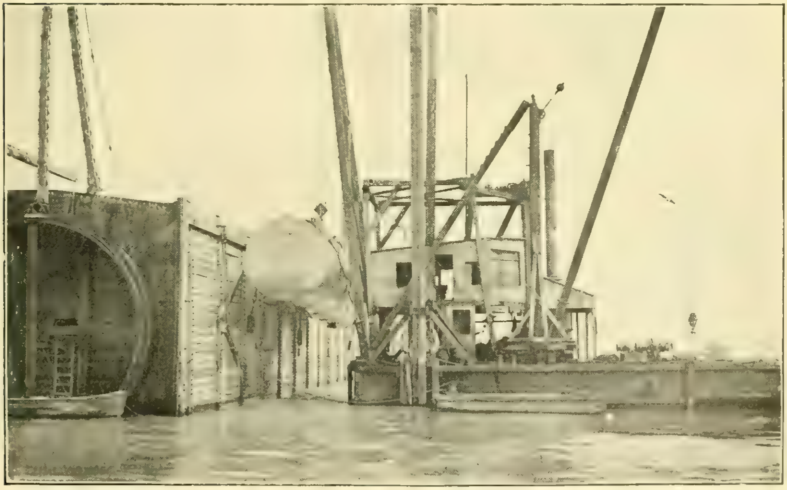


FIG. 2.—AIR CYLINDER BEING PLACED ON SECTION OF TUBES.

dredge with a specially designed boom. This was tried, but without success. An ordinary dipper dredge was provided with an 80-ft. steel boom and especially large engines. About two-thirds of the first three sections of trench were excavated with this dredge, but to a depth of only 45 ft. At greater depths the strain on the anchoring spuds was excessive, causing very expensive breakages. After several months' work, the dipper dredge was replaced by the clam-shell, which operated successfully throughout the remainder of the work. This dredge would undoubtedly work equally well in 100 ft. of water.

The clay from the trench was used as back-filling along the line of the tunnel outside the sheathing, after two sections of tubes had been placed and concreted. Prior to the sinking of the first two sections of tubes, all excavated material was towed in scows a distance of 6 miles down the river from the tunnel, and dumped at a point inshore from the harbor line. It might be interesting to note that great care had to be exercised not to waste any clay taken from Canadian waters across the boundary line into United States waters, unless for use as back-filling along the line of the tunnel. A violation of this restriction would undoubtedly have resulted in an imposed Customs duty.

Sinking the Tubes.—In advance of the sinking of a section of tubes, and before placing the grillage for the temporary end support, it was necessary to determine the condition of the trench as to depth and width. This was accomplished with a 24-in. I-beam, 48 ft. long, suspended by cables under a derrick scow, and dragged along the bottom of the trench. The line of the sweep was regulated by noting the position of the suspending cables with relation to ranges on shore. An encroachment of any consequence would retard the sweep and was readily detected. As a further verification of the record, two divers followed the sweep and reported general conditions, such as depth of trench below the sweep and nearness of the slopes of the cut to the ends of the sweep. This latter information was interesting, but not absolutely necessary for the determination of clearances in the trench.

At intervals, marking the joints between the different sections of tubes, a steel grillage of I-beams was placed at the required level, under which concrete was deposited until the beams were engaged by the concrete. These grillages formed temporary supports for the ends of the sections, until the foundation concrete could be deposited. A plan of the grillage is shown by Fig. 7, Plate CXIII, and a view is given in Fig. 1, Plate CXIX. Each grillage was placed by suspending it on steel cables, handled by derricks on the large scow which formed part of the floating equipment. At each of the four corners of the grillage was attached a 10 by 10-in. timber leg, or spud, about 10 ft. long, which was driven into the clay by an ordinary pile-driver drop-hammer, swung from one of the derricks, until the grillage was brought to grade. The grade was determined with a steel mast, 80 ft. long, which was used as a level rod, the leveling instrument being stationed on shore. The mast was handled by a derrick, and the lower end was placed on the corners of the grillage by a diver.

For sinking, the ends of the tubes were fitted with water-tight bulkheads. Each of these bulkheads was equipped with a 14-in. gate-valve, which could be opened from the outside. Each valve was just below the water-line when the section of tubes was floating empty. The sections were sunk by opening these valves and permitting the tubes to fill with water. The bulkheads were fitted at the top with a 2-in. air-escape valve, to which was connected a 2-in. hose of sufficient length to permit the loose end to extend above the surface of the water when the section of tubes was in its final position. To the end of the hose above water was attached a 2-in. valve for controlling the escape of air. The tubes were equipped on the inside with two semi-bulkheads, placed 48 ft. from the end bulkheads. These semi-bulkheads had a maximum depth of 7 ft., and when engaged by the water inside the tubes served to form, in connection with the end bulkheads, an air-chamber regulating the sinking of the section as a whole on even keel. In this manner the section was held in check and controlled in sinking until completely submerged. This control was established by valve-regulated air-escape pipes through the end bulkheads. When filling with water, the air in the tubes was permitted to escape through two 4-in. pipes, one back of each semi-bulkhead toward the middle of the tubes. These air-escape pipes were capped by divers after the tubes were in position in the bottom of the trench. The time required for submerging a section of tubes was approximately 2 hours.

Four air cylinders, or buoys, were used for floating the tubes to correct position, two being placed over each tube and connected to the diaphragms. These cylinders were of $\frac{1}{4}$-in. steel, and were 10 ft. 2 in. in diameter and 60 ft. long. Each cylinder was divided into three compartments; the length of the middle compartment was 13 ft.,

PLATE CXIX.
PAPERS, AM. SOC. C. E.
AUGUST, 1911.
KINNEAR ON
THE DETROIT RIVER TUNNEL.

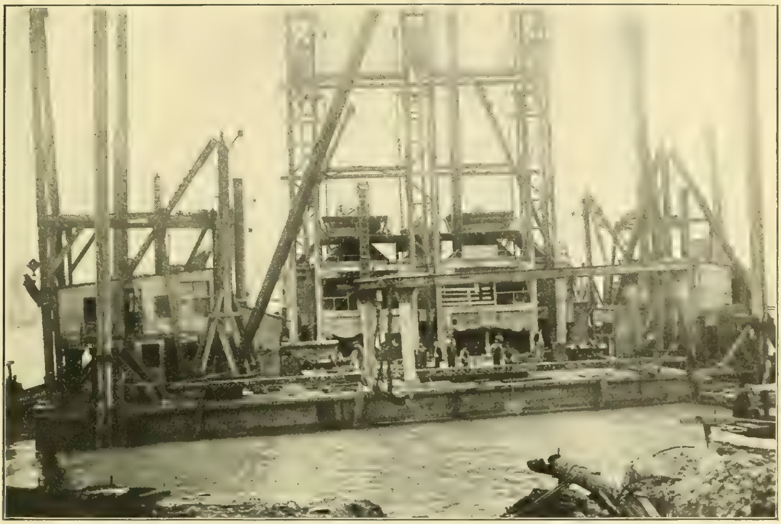


FIG. 1.—STEEL GRILLAGE USED AS TEMPORARY SUPPORT FOR STEEL TUBES.

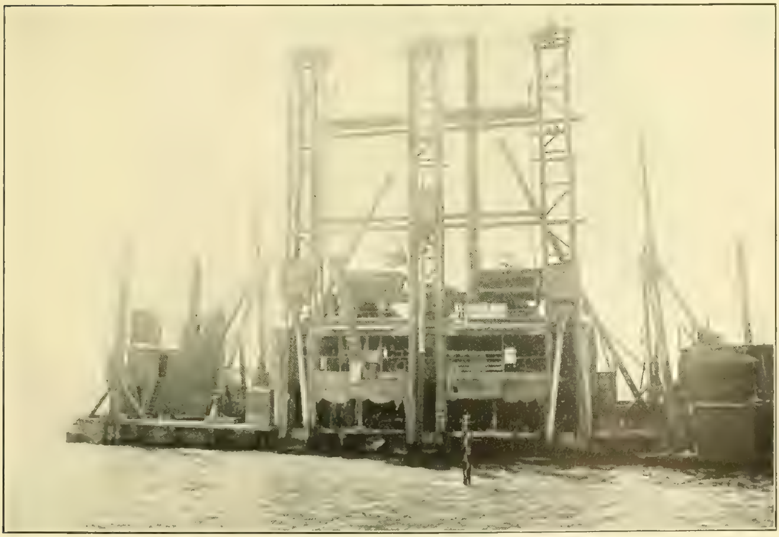


FIG. 2.—TREMIE SCOW IN OPERATION, SUBAQUEOUS SECTION, DETROIT RIVER TUNNEL.

and that of the end ones was 23 ft. 6 in. Each compartment was fitted at the top with a valve for admitting water, also with an air-escape valve. The middle compartment was also equipped with a valve at the bottom, which was controlled from the top of the cylinder and used for the rapid admission of water, this compartment only being used in regulating the sinking of the tubes. The air cylinders were proportioned so that, with the end compartments empty, the tubes filled with water and were completely submerged, the entire section being held in suspension with about 1½ ft. of the top of each of the cylinders visible above the surface of the water. The middle compartment was then permitted to fill with water, and the whole mass was lowered to its final position in the bottom of the trench. Further and more refined control of the section was obtained with two 5-ton counterweights, built of I-beams and handled by derricks mounted on a scow alongside. One counterweight was permitted to rest on top of each pair of air cylinders, and with sufficient water in the center compartment to overcome buoyancy, the additional load thus imposed produced a downward movement, which could be arrested at will. The cylinders were placed on the section of tubes, just before sinking, with a large **A**-frame on one of the scows, which was built as part of the plant to be used in connection with the sinking of the tubes. Fig. 2, Plate CXVIII, is a view of this scow with the **A**-frame placing an air cylinder on one of the sections. After a section of the tubes was in proper position in the bottom of the trench and sufficiently anchored by concrete, the air cylinders were detached by a diver, brought to the surface, and held in readiness for use on the next section. One set of cylinders was used for all the sections.

The total weight of the material in a section of tubes 262 ft. 6 in. long, with four air cylinders, was 900 tons, the metal weighing 550 tons, the wooden sheathing and bulkheads 240 tons, and the air cylinders 110 tons. The weight of the mass in water, when entirely submerged, was approximately 516 tons.

For holding the tubes in position against the current during sinking, two concrete anchors, weighing in water 22 tons each, were buried in the bottom of the river 700 ft. up stream from the line of the tunnel and opposite the ends of the section which was being lowered. The large derrick scow, 35 by 120 ft., equipped with large hoisting engines of the Lidgerwood type, in addition to the two derricks mentioned, was anchored up stream from the permanent location of the section and close enough for the derricks to handle the counterweights on the air cylinders. On the up-stream side of the tunnel section, attached to the diaphragms, were four large shackles, two at each end, one at the top and one at the bottom. To each of these four shackles was attached a set of tackles, consisting of 2-in. manila line, run through two sets of quadruple blocks. One of the blocks was attached to the shackle and the other to a 1⅜-in. cable leading to one of the anchors. The lines from the tackles were run to the drums of the engines on the scow, from which the whole system was controlled. Fig. 1, Plate CXX, is a view of a section of tubes being sunk. Fig. 4, Plate CXIII, is a sketch of the concrete anchor.

As has been stated, operations on the river were conducted from Detroit, toward Windsor, so that the west end of each section of tubes following Section No. 1 was connected to the east end of the preceding section. The connection was made by a specially designed joint, Fig. 5, Plate CXIII. On top of each tube at the west end was attached a pilot pin, so-called, 6 ft. long and 6 in. in diameter, slightly tapered at the end, which fitted into a socket, 6½ in. in diameter, on the east end of the preceding section. The pin near the end was slotted to receive a steel wedge, or key. This key, when driven home and locked, fitted tightly against the socket casting, thus holding securely in position the west end of the section of tubes which was being placed. With the pilot pins in place in the sockets, a tight joint was made between the connecting sections with the abutting ends of the tubes coinciding. The special joint provided an exterior annular pocket enclosing the connection, 4 in. deep and 8 in. long, which was made practically water-tight by an arrangement of rubber gaskets. After the tube was unwatered, this pocket was filled from the inside with neat cement grout. In addition to the pilot pins, the connection was further strengthened by bolts on the outside, which were placed by divers. To make the joint in the manner described, it was, of course, necessary that the east end of the section being placed should be in its final position.

The position of the section with respect to line and grade was determined by steel masts, one on each tube at the east end and one on the west-bound tube at the west end. These masts consisted of two channel-beams, 10 in. wide, set back to back, 10 in. apart, and con-

PLATE CXX.
PAPERS, AM. SOC. C. E.
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KINNEAR ON
THE DETROIT RIVER TUNNEL.

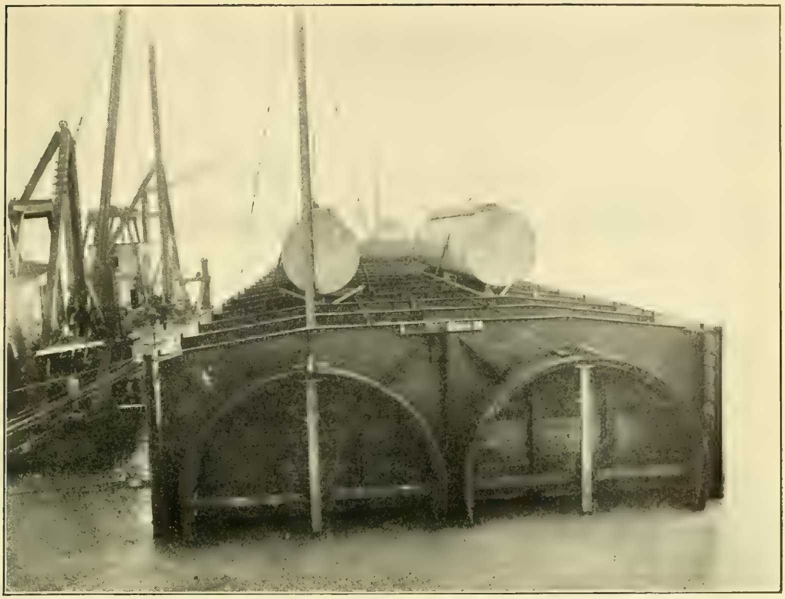


FIG. 1.—SECTION OF TUBES DURING SINKING.

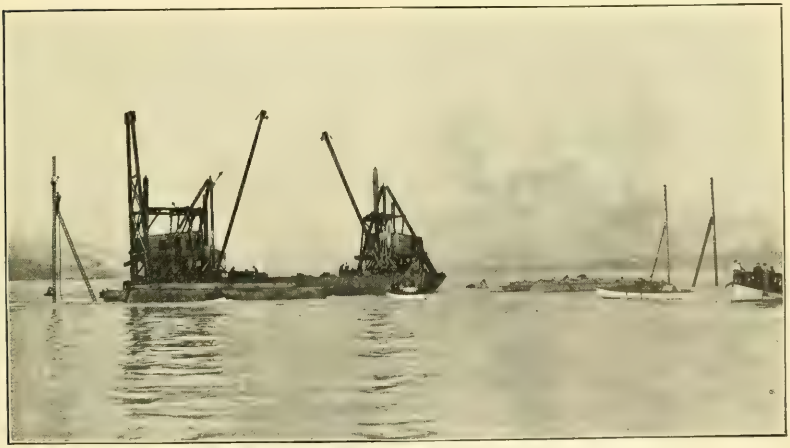
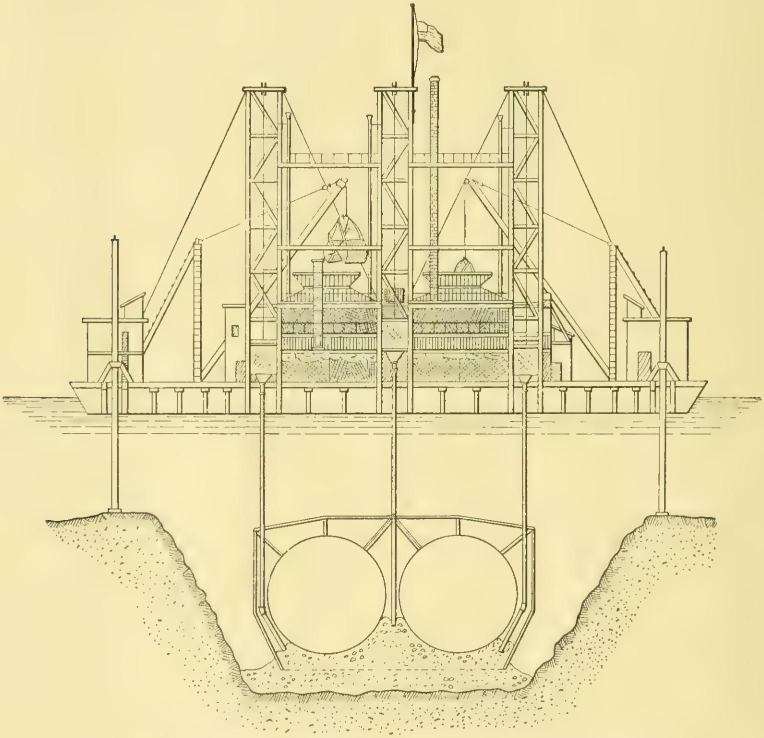


FIG. 2.—SECTION OF TUBES IN SUSPENSION BY AIR CYLINDERS.

nected by lattice bars. On each face was marked the center line, and the mast was graduated in feet, the numbering being referred to the center of the tube. Each mast was carefully set with its center line at right angles to the horizontal diameter of the tube and on center. Lines and grades were given by instruments on shore, and the tubes were adjusted by manipulating the holding lines.

The grillage was usually set several inches below the established grade of the bottoms of the diaphragms, in order to guard against its becoming too high, and shims were inserted between the bottom of the diaphragm and the beams of the grillage. This work was done by divers. The grillage was designed to engage four diaphragms, the two end ones of each section, but shims were placed under the end diaphragm only. It will be remembered that the tubes were carried almost in suspension by the air cylinders until the section was anchored by the exterior concrete deposit. When a section was finally adjusted, it was anchored temporarily to the grillage by a turnbuckle arrangement, Fig. 8, Plate CXIII, which was placed and made secure by divers. A remarkable feature in connection with the adjusting of the sections to final position was the perfect control which was obtained at all times, resulting from the use of the air cylinders. It was possible to raise or lower the tubes a fraction of an inch with the greatest ease and precision by regulating the quantity of water in the cylinders. The time consumed in sinking a section of tubes, adjusting, bolting, and making ready for the concrete, ranged from 3 to 7 days.

Exterior Concrete.—For depositing concrete, an especially large and well-equipped scow was built by the contractor. It was 36 by 155 ft., and was fitted with 20 by 20-in. timber spuds 90 ft. long. It carried a two-story structure which housed the concrete mixers, hoisting engines, and dynamo for lighting purposes, all of which were on the lower deck or floor of the scow. In addition to these there were two large derricks on the lower deck, which, when concrete was being deposited, were used for transferring gravel from the barges to the scows, gravel having been used on this work exclusively. The upper story of the superstructure contained three screening hoppers, above which were two bins, each with a capacity of 75 cu. yd., for receiving the gravel. The gravel was drawn from these bins and screened into the three hoppers. On the floor of the second deck, immediately under the screening hoppers, were three small hoppers just above the mixers, for proportioning the materials. On one side the scow was provided with three leads, each carrying a tremie pipe. These pipes were 26 ft. 4 in. from center to center, and extended to a height of 89 ft. above the surface of the water. These leads also carried the buckets for elevating the concrete to the upper ends of the pipes. At the top of each pipe there was a hopper for receiving the concrete, the connection of the hopper with the pipe being such that the pipe was free to swing laterally. The hopper carried a cage in which a man was stationed to direct the handling of the pipe when concrete was being deposited. The pipes were 12 in. in diameter, of spiral-riveted wrought iron, in 16-ft. lengths, with flange connections. The buckets for elevating the concrete were designed to dump automatically into the hoppers at the tops of the tremies. Fig. 2, Plate CXIX, shows the scow and the tremies in operation. Fig. 7 is a sketch of the scow.



METHOD OF PLACING CONCRETE BY TREMIE.

Fig. 7.

With a section of tubes in place, ready for depositing the exterior concrete, the scow was floated to position, the tremie pipes being placed directly over one of the pockets formed by the diaphragms where it was desired to work. The tremies were then lowered until the bottom ends were about 1 ft. above the bottom of the trench, with the middle tremie in the center between the two tubes and the side tremies between the outside of the tubes and the sheathing. To avoid delay, the tremie pipes were generally located in the pockets by divers. The pipes were left open at the bottom and filled with concrete to the exclusion of the water. To accomplish this the first two or three batches of concrete were mixed very dry, and the first two batches seldom failed to be effective. After the lower end of the pipe was sealed against the inflow of water by the initial deposit of the dry mixture, the concrete was mixed wet, as compared with the usual consistency of that placed in air, thus admitting of easy flow through the pipe. Under good working conditions, the rate of deposit through one of the tremies averaged about 30 batches per hour. The lower end of the pipe was generally held from 3 to 5 ft. in the concrete, and the concrete was discharged by raising the pipe slightly as each batch was dumped in the hopper at the upper end. The flow was carefully regulated, so that the pipe was filled with concrete from the beginning to the end of a run.

Due to the absence of any reliable data or records of experience in depositing large quantities of concrete in water of such depth as was found on this work, the contractors conducted numerous experiments with the tremies in the open trench before the actual work was started. Some very valuable information was gained through these experiments, resulting in the continuously successful operation of the tremies. In the early experiments it was found very troublesome to secure a slow discharge of the concrete. At times the pipe would be raised 8 or 10 ft. for the purpose of starting the flow, which would usually result in a rapid discharge of the concrete and the pipe filling with water. This action was found to be caused by the bottom of the pipe becoming clogged with clay when first lowered into the trench. The wad of clay was dislodged only after considerable jarring of the pipe, by raising and lowering it, and the charge of concrete was usually lost in the operation. This difficulty was the only one of importance encountered in depositing the concrete with the tremies, and, of course, was readily overcome after the cause was discovered. It was found, however, that the best results could be obtained only by observing the utmost care in the manipulation of the pipes.

Each side tremie, when depositing in the sections with sloping sides, was provided with a knuckle-joint near the lower end, so that the lower section of the pipe was free to swing laterally and was thus directed under the tube. This lower section was of sufficient length to reach the bottom of the trench. When the concrete had been carried up to the top of the sloping side, the lower section of pipe, together with the knuckle, was removed.

The usual order of procedure, in concreting under and around the tubes, was to fill one of the pockets near the easterly end of a section as soon as possible after the section was in position, thus forming a positive anchorage against lateral movement due to the action of the current in the river. After this pocket was filled, foundation concrete was deposited in the bottom of the trench under the entire length and width of the section. The concrete for the foundation, up to the bottoms of the diaphragms, consisted of one part cement, four parts of sand, and eight parts of gravel. The concrete above the bottoms of the diaphragms was a 1 : 3 : 6 mixture. The foundation concrete, deposited as it was under the entire section directly after the tubes were placed, sealed the bottom of the section against an inflow of clay from possible slides along the slopes of the cut and from any other foreign matter which might be carried into the trench. It also gave a bearing to the tubes over their entire length.

After the foundation concrete had been deposited, a pocket near the middle of the section was filled, thus securing an intermediate bearing. It will be remembered that the air cylinders were not removed until the tubes had been anchored and given a bearing as described. After the removal of the cylinders, the remaining pockets in the section were filled, the work being carried on continuously, as nearly as possible, from end to end of the section. Concreting operations in any one pocket were carried on continuously, or as nearly so as possible, from bottom to top, thus forming a monolithic block the size of the pocket. It will be noted that the plans show the concrete 6 in. above the top of the diaphragm, or 4 ft. 6 in. above the top of the tube. No attempt was made to finish off the top of the concrete; it was not disturbed when once deposited. The placing of the concrete was inspected by a diver, whose duty it was to see that it was carried to at least 6 in. above the top of the diaphragm at all points. The elevation of the concrete was afterward verified by soundings. The depth of the foundation concrete under the entire tunnel varies from 1 to 6 ft., according to the depth of trench left by the dredge.

The total quantity of concrete deposited under and around the tubes was 101 900 cu. yd., and it was placed in a working period of 18 months. The maximum quantity placed in one day of 16 hours was 1 069 cu. yd., and the maximum for any one month was 10 287 cu. yd. The average number of yards per day deposited around the tubes above the foundation, for the days on which work was done, was 349. The average cost per cu. yd. of the 1 : 3 : 6 concrete was about $4, and the average cost of the 1 :4 :8 foundation concrete was about $3.75. These figures include all costs for material, labor, and equipment.

It may be interesting to know something of the character of the 1 : 3 : 6 tremie-deposited concrete, as developed on this work. A large number cf cores, about 5 in. in diameter, were taken from one of the pockets by a 6-in. Davis calyx shot drill, operated from the surface of the river. These cores were tested in compression and developed a strength as high as 4 000 lb. per sq. in., the lowest being 2 740 lb., from a series of six cores chosen at random. The specimens were broken one year from the date of deposit. At one point borings were made through a depth of 35 ft. of concrete, from which 92% of the cores were obtained, ranging in length from 6 to 20 in. The remarkable character of the tremie-deposited concrete was later disclosed in two concrete bulkheads, formed by depositing the concrete inside of the tubes between the wooden bulkheads in two adjoining sections. The tremie pipe entered the tubes through a manhole (provided for other purposes) from which the cover was removed by a diver. These concrete bulkheads, by way of explanation, were placed as additional protection to the workings in the tubes previously sunk, until succeeding sections could be placed. It required the continuous use of explosives and three weeks' constant labor to remove each of these bulkheads. This concrete was a 1 : 2 : 4 mixture, and was particularly dense, as were all the other samples of the subaqueous concrete. Some 6-in. cubes, cut from the bulkhead concrete, developed a strength of from 1 800 to 3 040 lb. per sq. in. in compression. Probably the strength of these specimens was somewhat impaired by the work involved in shaping.

At two special joints the tubes were surrounded by a 1 : 2 : 4 mixture of concrete, and, after the tubes were unwatered, it was found that these joints were nearly water-tight. This is a development which must be considered in connection with the hydrostatic pressure, found to be about 30 lb. per sq. in. at the bottom of the tubes.

Back-Fill.—The work of back-filling the trench outside the sheathing was started immediately after two sections of tubes had been lowered and concreted. For the most part gravel was used to a height of 11 ft. above the foundation concrete, and the remainder of the trench was filled with clay as excavated by the dredge. Where the top of the tunnel projects above the original river bottom, the back-filling was carried up to the level of the concrete. Later, the clay back-fill was covered with rip-rap, deposited to a depth of about 2 ft., as a protection against the possible scouring action of the current. Where gravel was used as back-filling, it was deposited through 12-in., wrought-iron pipes, lowered into the trench from the gravel barges. The clay was dumped directly from the drop-bottom scows, in which it was loaded by the dredge, to a height determined from time to time by soundings. The rip-rap was dropped by a clam-shell from the surface of the water, the position of the scow carrying it being determined by ranges on shore.

Unwatering the Tubes.—The west end of the first section of tubes and the east ends of Sections Nos. 1, 3, 5, 7, 9, and 10, were each provided with a heavy bulkhead, of 10 by 10-in. oak timbers, heavily braced, and of sufficient strength to withstand the full hydrostatic pressure when the tubes were unwatered. The east ends of the other sections and the west ends of all sections, except Section No. 1, were provided with 4-in. bulkheads, useful only in connection with the sinking. In addition to the 14-in. inlet-valve, already referred to in connection with the sinking as being located outside the bulkhead, each bulkhead was fitted on the inside with a 10-in. valve for unwatering. It was found expedient during the progress of the work to use the 10-in. valves in the heavy bulkheads only, leaving the 14-in. valves on all the light ones open at all times, thus giving a continuous opening through two sections of tubes between two heavy bulkheads. The 14-in. valves on all heavy bulkheads were closed by the divers directly after the tubes were sunk. With this arrangement it was possible to unwater Section No. 1 before drawing the water from Sections Nos. 2 and 3, and likewise Sections Nos. 2 and 3 were unwatered through

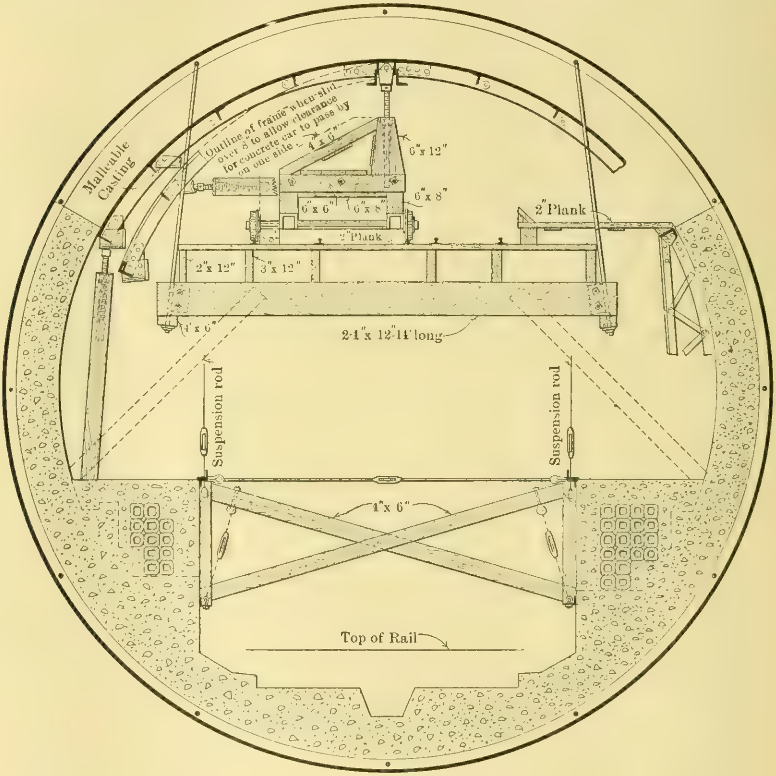
Section No. 1 without opening Sections Nos. 4 and 5, and so on across the river. In this manner it was possible to begin the placing of the interior lining of concrete before all the sections had been sunk.

The water was pumped from the first five sections of tubes by an 8-in. centrifugal pump, placed in the bottom of Section No. 1 in advance of its sinking. This pump was also used in unwatering all sections east of No. 5, being assisted by a similar pump placed at the east end of the latter. For carrying the water to the pump, a 12-in., wrought-iron pipe was laid through each of the first five sections in advance of sinking, that in Section No. 1 being connected with the pump. An access pipe, 4 ft. in diameter, designed to extend above the surface of the water with the tubes in place, was provided for each tube at the west end of Section No. 1, also a 12-in. discharge pipe. All these pipes were built as a part of the tubes before the section was lowered. The pumps were placed directly under the access pipes, and the pump shafts led up through these pipes.

After five sections of tubes were in position, and before the coffer-dam connection with the shore work was completed, Sections Nos. 1, 2, and 3 were unwatered, and preparations were made for placing the concrete lining. Sections Nos. 4 and 5 were next unwatered, and this work was continued progressively in pairs to the Canadian connection. Work on the concrete lining was started in Section No. 5, after seven sections of tubes had been placed and concreted outside, and before the water was drawn from Sections Nos. 6 and 7. This was directly after the coffer-dam connection was made between the Detroit shaft and the first section of tubes, and all material, except concrete, was handled through the shaft.

It may be of interest to note that when the different sections of tubes were unwatered, they were found to be water-tight, with the exception of a slight seepage at some of the rivets and at the lap-joints between the plates, where they may have been strained in launching. These small leakages were stopped by caulking with steel caulking irons and by the application, in a few cases, of red lead forced into the lap-joints by a small pump commonly used for such work.

Concrete Lining.—The cross-section of the concrete lining in the subaqueous section is shown on Plate CXVII, which also shows the location and size of the reinforcing rods used throughout this section, and the invert reinforcement in the approach tunnels. The concrete for the full section, from invert to arch, except that over the ducts, was placed in four runs, namely, the invert, to 12 in. below the top of the bench-walls; the two side-walls, to 8 ft. above the top of the bench; and, finally, the arch. The ducts were laid and concreted after the inverts, side-walls, and arch had been placed throughout the tubes.



DETROIT RIVER TUNNEL
SUSPENDED FLOOR CONSTRUCTION
AND POSITION OF FORMS

Fig. 8.

All concrete for inverts, side-walls, and arches was delivered in the tunnel over a platform suspended from the top of the tube at about the level of the top of the side-walls. Fig. 8 shows the details of this platform. Steel forms were used for the concrete lining, 24 ft. long for inverts and side-walls, and 12 ft. for the arch. The placing of concrete for inverts and side-walls was simple, but the arch work required

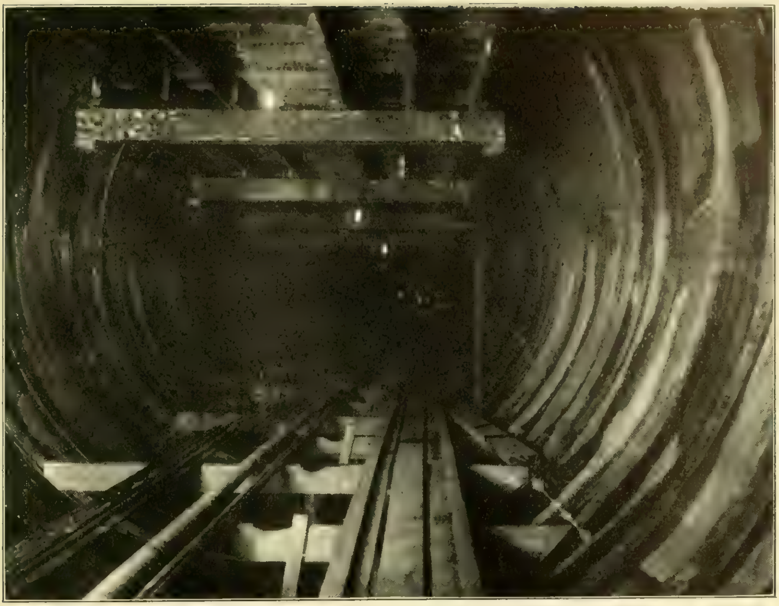


FIG. 1.—INTERIOR OF SUBAQUEOUS SECTION BEFORE CONCRETE LINING WAS PLACED.

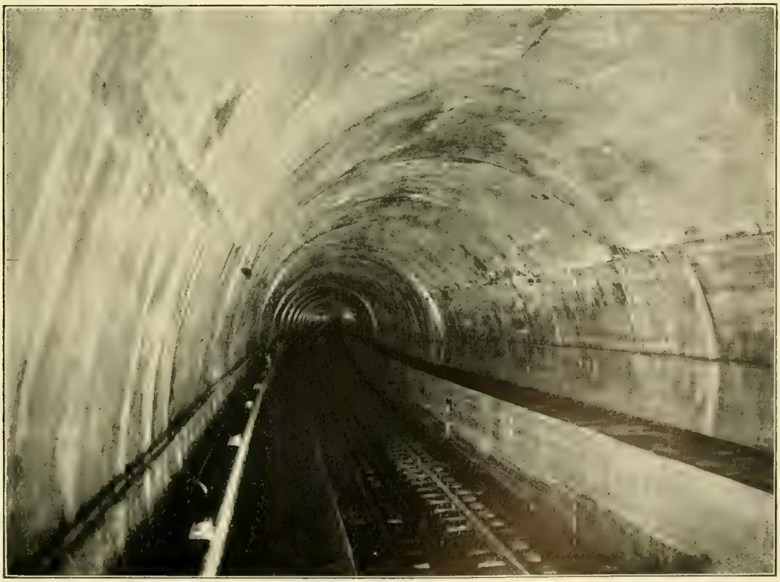


FIG. 2.—INTERIOR OF COMPLETED SUBAQUEOUS SECTION.

an end handling with shovels, followed by a ramming to place. All concrete for lining the subaqueous tunnel was mixed on the surface and delivered through chutes placed in the access pipes, previously mentioned. As the work of placing the lining progressed, the suspended platform was moved from the rear and placed in advance of the work as rapidly as the tubes were opened up, the narrow-gauge material tracks being shifted from the platform to the completed invert. Cars of material were handled from the low-level tracks to tracks on the swinging platform by an elevator. As all concrete for the tubes was mixed at the Detroit end, there was a haul of more than 2 700 ft. for the concrete placed near the Windsor connection. The cars were drawn by cables, and 30 min. was the longest time required for delivering a batch of concrete from the mixer to the farthest point of deposit. The concrete lining was completed in exactly 12 months from the time of starting. Interior views of the subaqueous tunnel are shown on Plate CXXI.

Connection Between the Subaqueous Tunnel and the Westerly Approach Tunnel.

Under the heading, "Westerly Approach Tunnel," it has been mentioned that the connection between the westerly approach and the subaqueous sections was made in the dry by a coffer-dam. By the time this connection was completed, seven sections of the steel tubes had been sunk and concreted, and the first three sections had been unwatered.

Shortly after the completion of the Detroit shaft, the westerly approach arches were built, in drifts, 2 ft. east of the shaft, to Station 158 + 23, leaving 52 ft. of tunnel section to be built in the open, the westerly end of the first section of tubes being at Station 158 + 75.

The original shore line on the Detroit side was 65 ft. east of the point where the connection was made between the subaqueous and westerly approach sections. The excavation for the trench to receive the first section of tubes thus left a small bay, about 200 ft. wide, at the water surface, over the ends of the tubes. The depth of the trench below the water surface at this point was from 55 to 60 ft., and the width at the bottom was about 60 ft.—slightly wider than the section of tubes. The side slopes, therefore, averaged a trifle more than 1:1. The ground surface at this point is about 5 ft. above the surface of the water, and the top of the concrete over the shore end of the tubes was

25 ft. 6 in. below the surface of the water, the latter in every case being the mean elevation, 574.2.

The enclosure between the ends of the tubes and the shaft was made by building a dam across the bay over the end of the first section of tubes. This dam consisted of concrete with a clay back-filling, deposited between rows of heavy wooden sheet-piling, on either side of the tunnel, and a crib sunk over the end of the tunnel, together with a further back-filling of clay outside of the crib and piling. The crib extended 30 ft. beyond each side of the tunnel, over the deepest part of the trench, thus providing ample width for the concrete wall. Having an inside width of 23 ft., the rows of sheet-piles along the crib meeting the sides of the tunnel, were 26 ft. apart inside. The two rows of sheet-piles extending from each end of the crib to the bank on either side were 25 ft. apart at their connection with the crib, narrowing down to 10 ft. at the bank as the water became more shallow, and were driven with the outside row at an angle of about 30° with the connecting row along the crib to form, as it were, a wing-wall at either bank.

The crib, 111 by 23 ft., with a total height of 29 ft. 6 in., was assembled in the water over the tubes and sunk as timbers were added, being guided to position by the piles driven in the trench inside of the lines of its proposed location. When in position, the crib rested on 12 by 12-in. timbers, which had been attached to the tops of the two end diaphragms before the tubes were sunk. For convenience in concreting, the crib was divided into four compartments, separated by solid timber walls at right angles to its axis, one over each side of the tunnel sheathing and one over the center line of the tunnel. All the outer and division walls were of 6 by 12-in. timbers. After the crib was in place, the sheet-piling was driven. This consisted of 16 by 16-in. timbers along the crib, built up of 8 by 16-in. bridge stringers, and 12 by 12-in. pieces in the wings, built up of 6 by 12-in. car-sills. The length of the heavy 16 by 16-in. piles ranged from 50 to 80 ft., and the others from 30 to 50 ft. The piling was driven to a penetration of from 12 to 15 ft. The 16 by 16-in. assembled timbers were connected by tongued and grooved joints by attaching to one side of each piece two 4 by 5-in. splines, making a 4 by 6 in. groove, and to the opposite side a 4 by 6-in. piece to serve as a tongue. The 12 by 12-in. piers were connected in the same manner.

PLATE CXXII.
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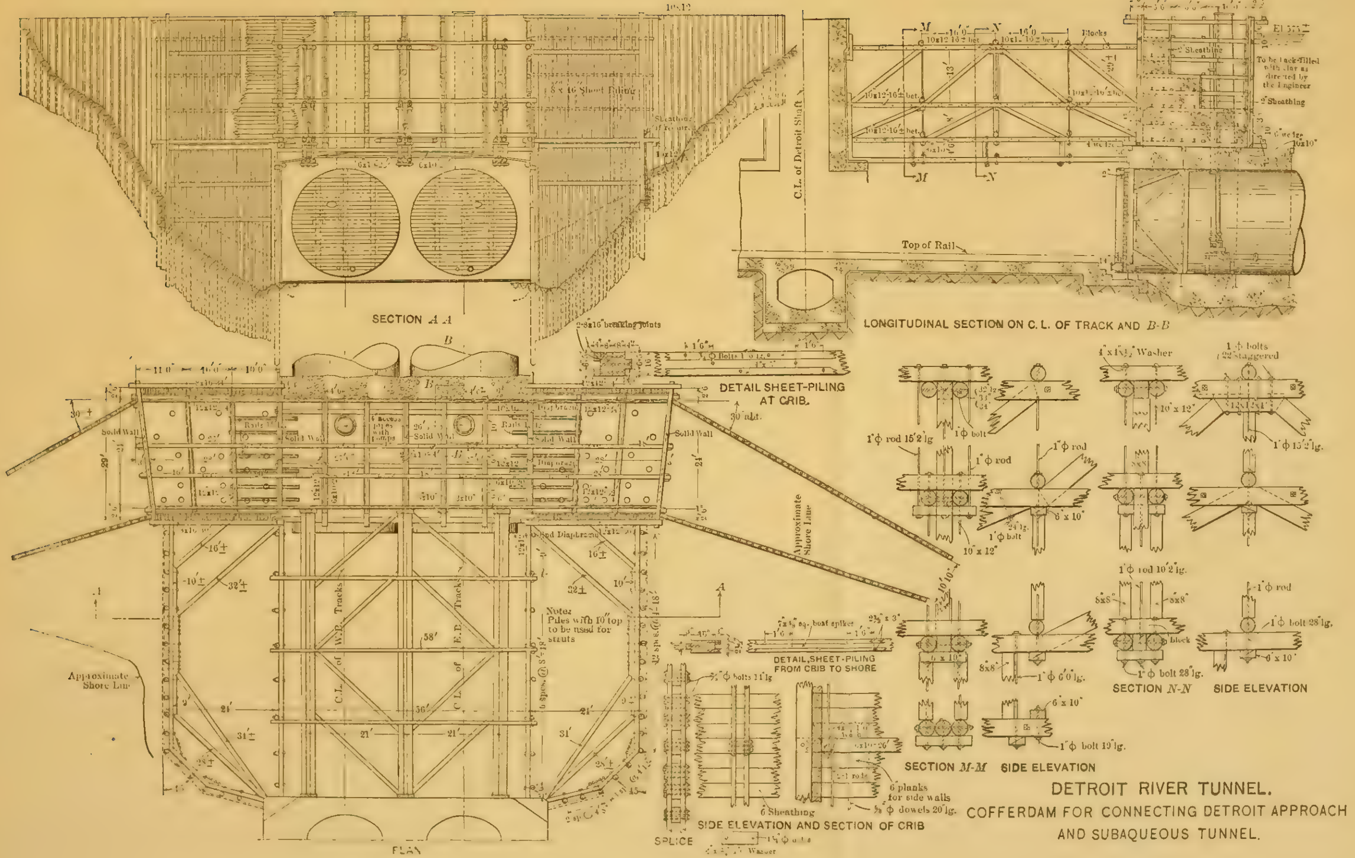
THE DETROIT RIVER TUNNEL.



SECTION A-A

LONGITUDINAL SECTION ON C. L. OF TRACK AND B-B

DETAIL SHEET-PILING AT CRIB.

DETAIL, SHEET-PILING FROM CRIB TO SHORE

SECTION N-N

SIDE ELEVATION

SECTION M-M

SIDE ELEVATION

SIDE ELEVATION AND SECTION OF CRIB

SPLICE

PLAN

DETROIT RIVER TUNNEL.

COFFERDAM FOR CONNECTING DETROIT APPROACH AND SUBAQUEOUS TUNNEL.

Concrete was deposited first in the side pockets of the crib, up to the top, above the surface of the water, and considerable time was allowed to elapse between the filling of these pockets and those over the tunnel, so that any settlement of the concrete in the side pockets would not cause settlement of the tubes, as the concrete over the latter was bonded to that on the sides by steel rails. The space between the rows of piles under the side pockets of the crib, up to the top of tunnel, was filled with concrete; above the level of the top of tunnel, the concrete in the side pockets and over the tunnel was deposited to the shape of a gravity retaining wall, 6½ ft. at the top, stepping off on the river side to the full width of the crib at the top of the tunnel. The remainder of the space in the crib was filled with clay. The wings were filled with concrete to within 12 ft. of the surface of the water, and above this the space was filled with concrete to an average width of 10 ft. on the inside and with clay on the river side. To complete the dam, clay was deposited in the river, next to the sheet-piling and the crib, to the surface of the water.

On the completion of this heavy cut-off wall, which was 228 ft. long, with a maximum height of 60 ft., the water was pumped from the enclosure between the wall or dam and the tunnel shaft, and the necessary excavation was made, to complete the tunnel section from the shaft to the tubes. As the water was lowered and the excavation carried down, heavy horizontal, timber braces were placed, reaching from the dam to the shaft, a distance of 55 ft. These braces were arranged in five courses from the level of the water in the river down to the top of the tunnel, and were braced horizontally and vertically to prevent deflection. The braces formed a mutual support between the dam and the shaft, although they were used more to prevent a listing of the shaft than as a support for the dam. The coffer-dam and bracing are shown on Plate CXXII. As the excavation was carried downward, the sides of the cut were retained by rows of sheathing driven at several levels, forming a series of terraces. The sheathing was braced securely by cross-struts extending from side to side of the cut. There was evidence of tremendous pressures on the transverse struts, but none on the longitudinal braces between the dam and the shaft. The material was excavated by hand, and removed in buckets handled by derricks set up around the top of the work. The closing section of the tunnel was built without any trouble, as there was very little seepage through the dam, and the work was completed in a very short time after the excavation.

This section of the tunnel was water-proofed with ten layers of felt and eleven of pitch, applied alternately, as previously described. The concrete connecting with the tubes was placed so as to surround their ends completely, with a minimum thickness of 12 in., and was extended 2 ft. east of the ends of the tubes, to meet the first steel diaphragm. The water-proofing was carried to a lap-joint at the diaphragm, and this union was covered with a very rich mixture of concrete to a thickness of 3 ft. over the arches and 2 ft. on the sides down to the invert.

The space enclosed by the coffer-dam was back-filled with clay up to the original surface of the ground as soon as the connection was made and the water-proofing completed.

Connection Between the Subaqueous and the Easterly Approach Tunnels.

As mentioned in the description of the easterly approach tunnel, that portion of this section of the tunnel immediately adjacent to the subaqueous tunnel was completed under compressed air, in drifts, down to the actual point of connection. The extrados of the arches at the end of the concrete section outside of the water-proofing was covered by a steel plate, which was bent normal to the axis of the tunnel over the end of the section, and served as a water-proof surface against which the steel tubes abutted when in place, thus providing a water-tight joint similar to that between the sections of tubes, shown in Fig. 5, Plate CXIII. When the trench was excavated for the connecting section of tubes, the clay was removed by the dredge from around the end of the approach tunnel, and the tubes were sunk to place in the usual manner. To prevent an inrush of water to the approach tunnel when the end was uncovered, three heavy concrete bulkheads, 50 ft. apart, provided with steel doors, were built as a part of the tunnel close to the point of the proposed connection.

A grillage was sunk in the trench adjoining the approach tunnel, to provide a temporary support for the tubes. This grillage was similar in every respect to those used at other joints, except as to width. The closing section of tubes, known as Section No. 11, was 64 ft. 6 in. long, and the gap between the easterly end of Section No. 10, the last full-length section, and the approach tunnel was 65 ft. 4 in., thus leaving 10 in. between Sections Nos. 10 and 11 when the latter was in place against the end of the approach tunnel. The opening thus left between these sections afforded an opportunity to use a joint of special design, which was easily made by the divers, and the closure was sealed by the deposit of exterior concrete. When the tubes were unwatered, they were made continuous over this joint by inserting a plate on the inside, which was bolted to the tubes and caulked so as to be water-proof. The joint provided a small annular space between the plate inserted and the exterior concrete. This space was grouted from the inside of the tubes, thus eliminating any possibility of voids between the outside of the tubes and the exterior concrete.

Construction of the Steel Tubes.

The contract for the construction of the steel tubes was sublet by the general contractor to the Great Lakes Engineering Works, of Detroit. The work was done according to plans and specifications approved by the Detroit River Tunnel Company, and under the latter's supervision. The tubes were erected at the St. Clair plant of the Great Lakes Engineering Works, at St. Clair, Mich., 60 miles north of Detroit, on the St. Clair River.

The method of laying out and assembling the shell-plates was similar in every way to that used in the building of lake freighters. All plates were made from templates laid out in the mould loft from developed surfaces. This method is known, throughout the United States and Great Britain, in shipbuilding work, as the "Universal System of the Great Lakes."

The plates for the tubes were riveted together with lap-joints and attached to the steel diaphragm by an angle-iron, running entirely around the tube, riveted to the diaphragm and to the tube plate, the diaphragms being being spaced so as to come at the center of the plate between the lap-joints. The tubes and diaphragms were erected in the following manner: The diaphragm plates were assembled and laid out on wooden barrels; butt-straps were bolted to the butts of the plates, and the angle-bars which connect to the sheathing were bolted on; finally, the angle-irons to connect with the tube were bolted in place, thus giving a big frame of plates and angles in which was a hole 26 ft. 4 in. in diameter. Four half diaphragms were laid out at one time in the manner described, and then raised to position on keel-blocks, as shown on Plate CXXIII. The keel-blocks rested on concreted beds, and were carefully leveled before erecting work was started. The diaphragms were held temporarily in an upright position by longitudinal tie-angles bolted across the tops. When the diaphragms were erected and properly supported, the curved shell-plates were bolted in place temporarily, the intermediate plates between the diaphragms being placed last in all cases. The plates were cut so that the centers of the vertical lap-joints were 6 ft. apart, four plates forming a complete ring 6 ft. long. They were assembled with the horizontal joints of the successive 6-ft. rings staggered.

When an entire section of tubes was erected and securely bolted, and before riveting was started, the tubes were checked for alignment and grade, and any necessary change was made by moving the diaphragms.

After correction was made for alignment and grade, the riveters were started at work, and following them the caulkers. Air tools were used in both riveting and caulking. The caulking was done just as in boiler construction, the plate edge at the lap being flattened cold and pressed, or annealed, so to speak, into the plate underneath.

To insure a good fit at the joint between the sections of tubes, when they should finally be in place in the bottom of the trench, the connecting ends of adjoining sections were fitted together in the shipyard and tested with a water pressure of about 30 lb. per sq. in., which corresponds closely with the hydrostatic pressure at the lowest point of the tunnel.

The wooden sheathing along the sides, for retaining the concrete deposit around the tubes, was placed at St. Clair, as were also the wooden bulkheads, before the tubes were launched. Very little work remained to be done on the different sections of tubes after their arrival at Detroit.

About 20 months were required for building all the sections of tubes complete.

Tunnel Details.

Clearance.—The tunnel as built provides an overhead clearance from top of rail to crown of arch of 18 ft. 0 in., the arch section being a semicircle with a radius of 10 ft. The distance between

PLATE CXXIII.
PAPERS, AM. SOC. C. E.
AUGUST, 1911.
KINNEAR ON
THE DETROIT RIVER TUNNEL.

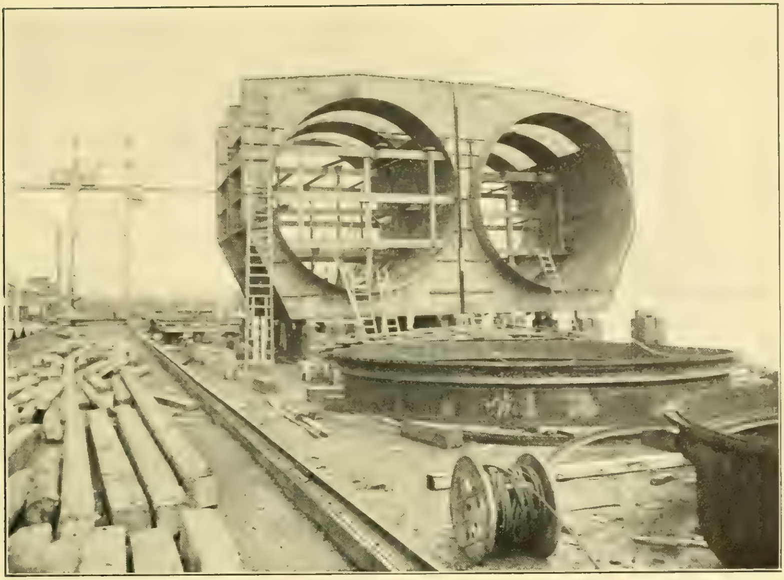


Fig. 1.—Tubes During Erection at Shipyard.

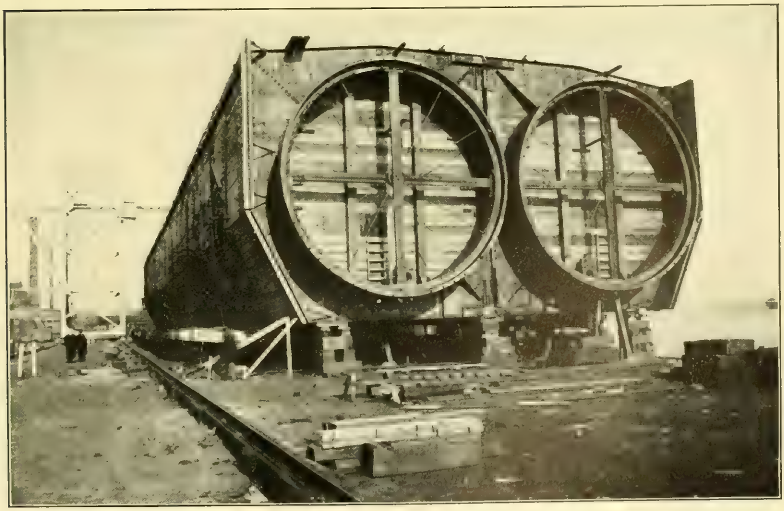


Fig. 2.—Tubes During Erection at Shipyard.

bench-walls, the tops of which are 5 ft. 3 in. above the top of rail, is 11 ft. 6 in.—5 ft. 9 in. on either side of the center line, on a tangent, and increasing ¾ in. per degree of curve, or ⅜ in. on either side of the center line.

Safety Ladders.—For safety and convenience, ladders were provided throughout the tunnel, at intervals of 50 ft., in each bench-wall. They extend from the level of the top of rail to the top of the bench; the rungs are of 1-in. pipe, 2 ft. long, built into niches in the wall, 4 in. deep. In the top of the bench, just over the ladder, there is a countersunk hand-hold of 1-in. pipe. The ladders in the two walls of each tube are staggered so as to make the distance between them 25 ft.

Lighting.—The tunnel is lighted by 16-c.p., 110-volt, incandescent lamps, at intervals of 40 ft. along each wall. The lights on the opposite walls of each tube are staggered, thus furnishing a light every 20 ft. The light wires are carried through wrought-iron pipes, built in the walls, two for each line of lights, thus providing for two separate and distinct circuits. The system is arranged with alternate lights on the same circuit, so that in the event of the current on one circuit being off for any reason, the lights on the other will in all probability be in service. Connection with the wires is made through special steel outlet boxes, one for each light, built in the wall, through which the 1-in. pipes pass. The lights are about 7 ft. above the top of the bench-wall.

Conduits.—Conduits for telegraph, telephone, power, and lighting cables are built in the walls, as shown by Fig. 6. These duct lines have outlets through special cable shafts in the main shafts and through the walls of the open cuts to duct lines on the surface. The lighting cables through the ducts are on a 600-volt circuit, transformed to 110 volts at special chambers at stated intervals through the tunnel, where connection is made with the light wires.

Splicing chambers, at intervals of 400 ft., are built in the walls along the power, telephone and telegraph, and light-wire duct lines.

Drainage.—All water coming to the tunnel will be taken care of by five sumps, one in each portal, one in each approach near the river, and one in the subaqueous section, under the middle of the river, their capacities ranging from 30 000 to 40 000 gal. each. For the discharge of the water, each sump is provided with rotary pumps driven by electric motors. Under the center of the track, leading to the sumps through each tunnel, is a ditch in the concrete, 6 in. deep in the approach tunnels and 10 in. in the subaqueous tunnels, as shown in the tunnel cross-sections. It is calculated that these ditches are of ample capacity to take the maximum flow of water during the heaviest rainfall which is likely to occur. Although the capacity of the sump in the subaqueous tunnel is 30 000 gal., it is not expected that very much water will ever reach it, as there is practically no leakage in the tunnel, and most of the water, even during the heaviest rainfall, will probably be intercepted by the sumps in the approach tunnels. The details of the subaqueous sump are shown on Plate CXXIV.

Ventilation.—As all trains through the tunnel will be operated by electric locomotives, no special system of ventilation has been provided.

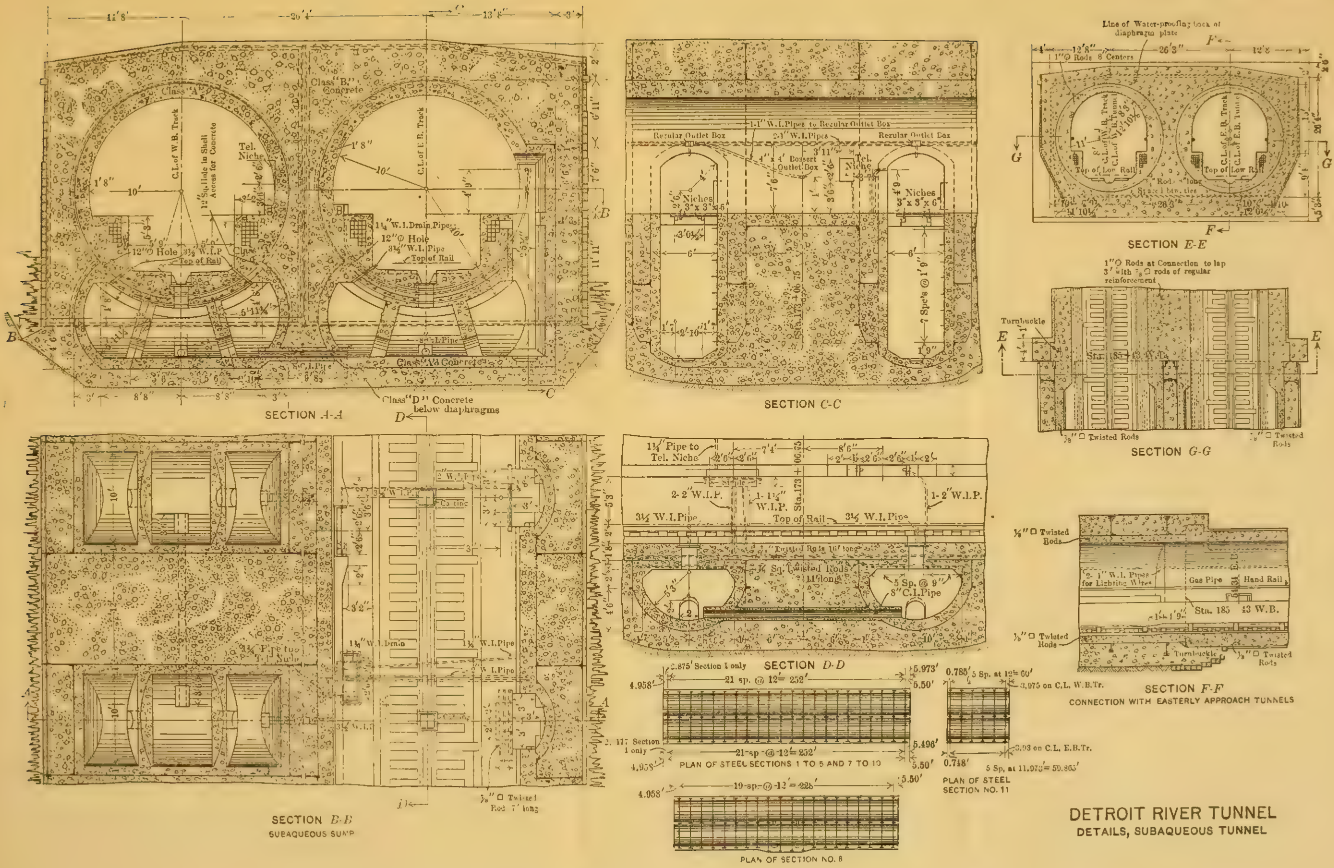
Track Construction.—The track construction in the tunnel differs from the ordinary type in that the ties are not continuous from rail to rail. Each rail rests on ties 3 ft. long; their outer ends are 19½ in. from the gauge of the rail and the inner ends at the edge of the gutter. Every fifth tie on the right-hand side, in each tube, looking in the direction of traffic, is extra long, to provide support for the third-rail. The ties rest directly on the concrete invert, which was built up to the grade of the bottoms of the ties. Each tie is laid on a bed of mortar $\frac{1}{16}$ in. thick for bonding purposes, and the ties are held in place by concrete placed between them to a depth of 5 in. at their outer ends, sloping toward the gutter to a thickness of 4 in. Bond between this concrete and the invert proper is furnished by dowels.

Before the tunnel was built, a short section of the Michigan Central Company's main-line track was changed to conform to the design proposed for the tunnel. This test section of track proved highly satisfactory, and the design was accordingly approved and adopted.

The standard tie used in the tunnel is 8 by 11 in., and the rail is the 100-lb., Am. Soc. C. E. section.

The general type of track construction, where separate ties are used for each rail, is not at all new, having been used years ago on some of the first railroads built in the United States. The details

PLATE CXXIV.
PAPERS, AM. SOC. C. E.
AUGUST, 1911.
KINNEAR ON
THE DETROIT RIVER TUNNEL.



SECTION A-A

SECTION C-C

SECTION E-E

SECTION G-G

SECTION B-B
SUBAQUEOUS SUMP

SECTION D-D

PLAN OF STEEL SECTIONS 1 TO 5 AND 7 TO 10

PLAN OF STEEL SECTION NO. 11

PLAN OF SECTION NO. 6

SECTION F-F
CONNECTION WITH EASTERLY APPROACH TUNNELS

DETROIT RIVER TUNNEL
DETAILS, SUBAQUEOUS TUNNEL

of the design for this permanent track construction were developed in the offices of the Tunnel Company. Views of the track are shown on Plate CXXV.

Fire-Hydrants.—The tunnel is provided throughout with a 6-in. water line, with hydrants every 100 ft. for protection against fire. Alarm boxes are located at intervals of 100 ft., with connection to the sub-station where the alarm is sounded.

ELECTRIFICATION.

After a thorough analysis of the operating requirements and the various systems of electrification, the continuous, or direct, system was selected as best suited to the conditions.

On account of the rather poor load factor, due to high peaks caused by the hauling of 1 800-ton trains on ascending grades, and then periods when no traction load is on the system, a careful study was made in order to decide on the most economical and reliable supply of energy. It was found better to enter into a contract with the Detroit Edison Company for the purchase of primary current than to erect a generating plant. The rate accepted required a practically constant load on the Edison Company's plant and necessitated the erection by the Tunnel Company of a sub-station costing approximately $260 000. Its location is near the Detroit shaft, on the river front, and about 3 miles from the power-house, to which it is connected by three cables, any one of which has ample capacity to furnish the three-phase, 60-cycle, 4 400-volt current sufficient for the average 24-hour load on the sub-station.

The sub-station equipment for the beginning of operations consists of two 1 000-kw. motor-generator sets, a 2 520-ampere-hour, 650-volt, storage battery, with booster and regulating appurtenances, and the auxiliary equipment necessary to furnish power for lighting, pumping, signaling, etc. The storage battery, with its regulating equipment, keeps the input to the sub-station nearly constant, and, in conjunction with one of the motor-generator sets, will supply power for peak loads as high as 9 000 amperes.

The third-rail is of the Wilgus-Sprague under-running type, 70 lb. per yd., and its total length, for the initial installation, is 18½ miles. The distance from the east to the west end of the third-rail district is from Station 79 to Station 372, about 4.4 miles. At the shafts and summits, 650-volt feeders from the sub-station are joined to the third-rail. At the summits, where interlocking towers are located, sectionalizing switches have been installed, so that portions of the third-rail in either of the yards or the tunnels may be "cut out" for repairs, or in case of trouble.

In the tunnels provision has been made to erect an overhead contact conductor should it be desirable.

The locomotives were built by the General Electric Company, and exhaustive tests, on the first of the six ordered, demonstrated that the type is well suited for the operating requirements. The following is a brief description of the type of locomotive in service: General Electric Company's classification: 0440-E-200-4 G.E. 209A—which is the conventional method of stating that it is an articulated, four-axle type, weighing 200 000 lb., equipped with four 300-h.p. motors of the geared railway type.

Weight of one motor	10 560 lb.
Weight of all electrical parts	53 000 “
Weight of all mechanical parts	147 000 “
Weight on drivers	200 000 “
Diameter of drivers	48 in.
Rigid wheel base	9 ft. 6 “
Total wheel base	27 “ 6 “
Gear reduction	4.37
Designed for trailing load: 900 tons on 2% grade at 10 miles per hour, with 600 volts at the third-rail.	
Maximum tractive effort	67 000 lb.
Balance speed on level, running light	35 miles per hour.

Each of the five sumps is equipped with duplicate sets of alternating-current, motor-driven, centrifugal pumps, and a third direct-current, motor-driven pump for emergency is installed at the Windsor portal sump to operate from third-rail current. The portal sumps have capacities considerably in excess of the requirements for taking care of any recorded rainfall, and the others are large enough to take care of the water should the portal sumps, for any reason, be out of service.

The signaling is arranged so as to make one block from portal to portal, in each tunnel, and the four interlocking plants—two in each yard—operate the signals and switches electrically.

PLATE CXXV.
PAPERS, AM. SOC. C. E.
AUGUST, 1911.
KINNEAR ON
THE DETROIT RIVER TUNNEL.

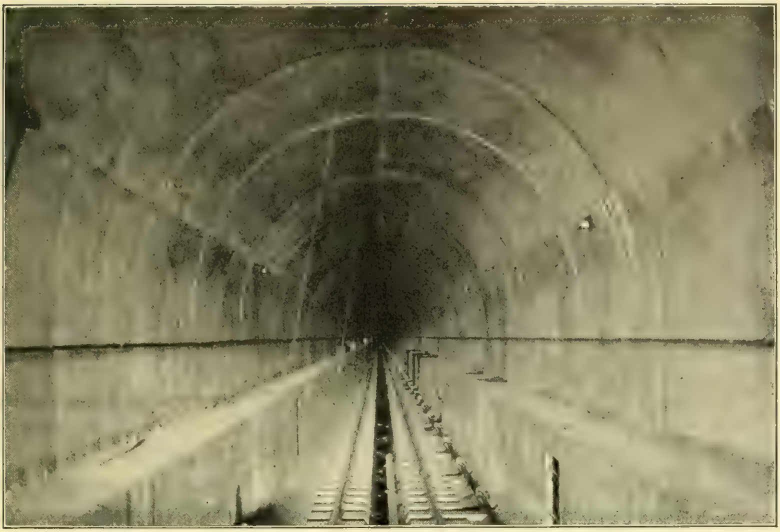


FIG. 1.—INTERIOR OF APPROACH TUNNEL.

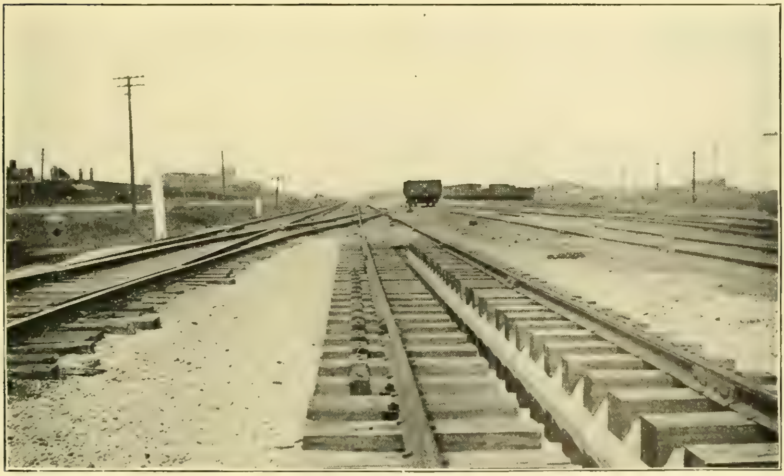


FIG. 2.—TYPE OF TEST TRACK USED IN DETROIT RIVER TUNNEL.

The yards are lighted by series arc lamps and the tunnels by incandescent lamps.

A fire-alarm and a telephone system have been installed, which provide means of quick communication between all the maintenance and operating men, to take care of regular work and emergencies.

TERMINALS.

When the location of the tunnel was approved, it was known that the approaches would destroy the efficiency, as then operated, of two Michigan Central yards, a small one in Detroit, and the terminal yard in Windsor. Steps were immediately taken to acquire property for a new yard at Windsor, and arrangements were made for the complete yard coincident with the completion of the tunnel. An ideal location, close to the tunnel summit, and just east of the old yard, was available, and as the land was practically all farm property, no extraordinary expenditure was necessary for real estate. In Detroit a somewhat different situation was presented. The main switching yard is about 3 miles west of the westerly summit of the tunnel, on the outskirts of the city. The right of way through the city is comparatively narrow, and, on account of the large number of adjacent industries, it seemed to be out of the question, during the preliminary study, to widen or in any way enlarge the facilities of the railroad for any great distance without unwarranted expense, so that all plans were necessarily made and based on the right of way as then owned by the Michigan Central.

It was at first thought that the interchange of power in Detroit for tunnel trains might be made at the large yard west of the city. When the original report was made by the Engineering Committee of 1904, the feasibility of electrifying a small receiving and delivering yard near the tunnel summit, where electric and steam engines could be interchanged, was suggested, but the question being one of operation, was not determined at the time. It was apparent that some of the tracks through the city would have to be electrified, which immediately gave rise to the problem of the separation of street grades.

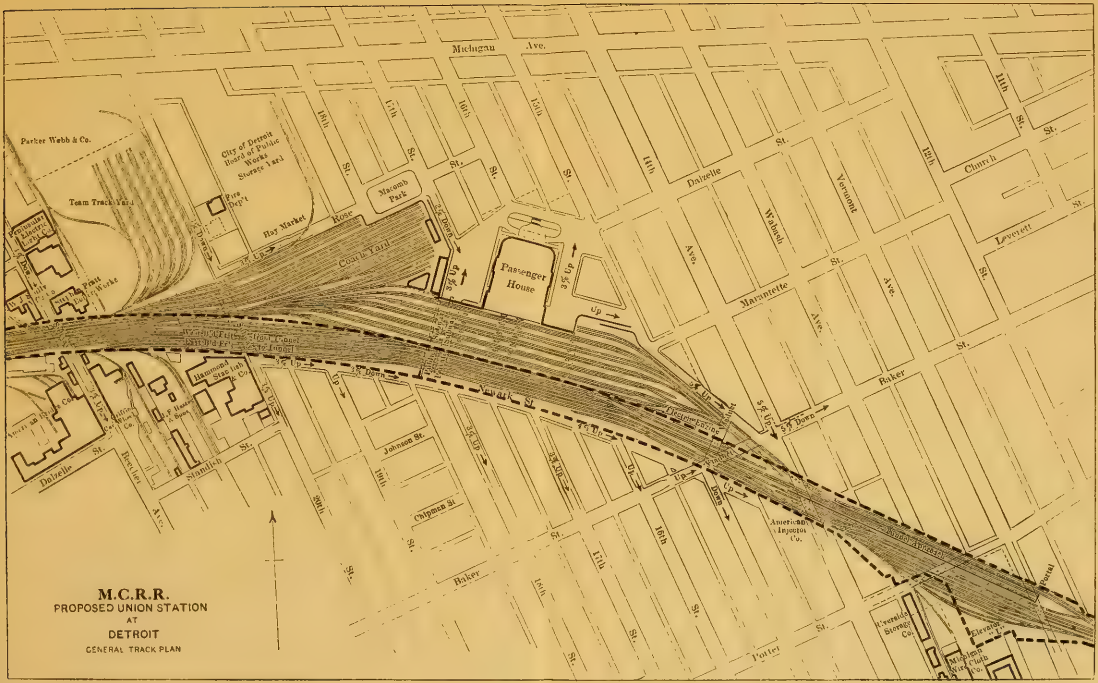
West of the tunnel summit, the railroad crossed, at grade, a number of streets on which the traffic was very heavy, and, as the tunnel plans contemplated the use of an electrified third-rail, the Committee, for reasons which are obvious, urged strongly that the grades at all cross streets between the tunnel summit and the Junction Yard, West

Detroit, be separated. Under an agreement with the City of Detroit, grade separation work of considerable magnitude had been in progress for several years in different parts of the city, and the recommendation of the Committee was promptly adopted.

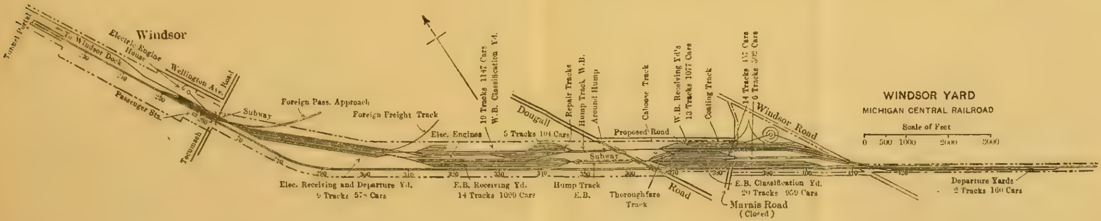
On account of local conditions, subways are being built at all streets which are to remain open for traffic, some thirteen in all. Within the limits of this subway construction, some 2¼ miles, there are fifty or more industries served by thirty industrial tracks. The tracks have been elevated an average of about 6 ft., and all the work is being done without the purchase of additional property.

By the acquisition of some additional property immediately west of the summit of the tunnel, it was possible to arrange for an interchange yard to serve the requirements of the tunnel traffic, thus limiting the electrification of the tracks on the west to 24th Street. With the new layout of tracks, shown on the upper part of Plate CXXVI, six tracks are reserved for freight movement through the tunnel, forming a combination known as a receiving and delivering yard. Each track has a capacity of 55 cars, 42 ft. long. Switches and cross-overs are provided, so that engines can pass quickly from the west-bound to the east-bound yard, and also from the freight yard to the passenger interchange yard. Near this yard, and convenient for the prompt handling of electric power, there is a small engine-house where electric locomotives are repaired. A new passenger station, between 15th and 17th Streets, is now under way, and until this is completed, tracks have been reserved for the exchange of electric and steam power at a point near 17th Street, from which point to the Third Street station trains are handled entirely by steam locomotives.

The New Station.—The present passenger station of the Michigan Central Railroad in Detroit is a little more than a mile east of the westerly summit of the grade of the tunnel, and its continued use would require the extra handling of all passenger trains between 17th and Third Streets. A new station was therefore necessary, and careful study of the situation promptly determined the proper location and type. It was obvious that the proper location for such a structure, if conditions could be adjusted, was as near the summit of the grade of the tunnel as possible. The character of the passenger traffic on the Michigan Central governed in the selection of a through rather than a terminal station. The development of the plan for a through sta-



M.C.R.R.
PROPOSED UNION STATION
AT
DETROIT
GENERAL TRACK PLAN



WINDSOR YARD
MICHIGAN CENTRAL RAILROAD

tion in the new location involved the purchase of a large amount of property, but this has all been acquired and preliminary work on the baggage, mail, and express-rooms and the station proper, is now well under way. The track arrangement for the new station is shown on the upper part of Plate CXXVI.

The presence of the third-rail in the station tracks was one of the governing elements demanding consideration, and, in connection with a comparison of street and track grades, forced a conclusion favorable to a subway handling of passengers to and from trains.

The Bush type of trainshed will be used, like that adopted for the Lackawanna Station, in Hoboken, N. J., and the new Chicago and North Western Station in Chicago.

The Windsor Yard.—As previously stated, when the plans for the tunnel were being prepared, it was known that the easterly approach to the tunnel would destroy the Windsor yard, and a new location was accordingly selected, where a modern yard could be developed at a reasonable cost. The new location called for the purchase of a strip of land 500 ft. wide and 2½ miles long, immediately adjoining the railroad right of way on the north. This property was crossed by three highways; one was closed, one was diverted, and the third was taken care of by a subway. Several miles of new roads were built in lieu of the closed highway, thus caring for abutting property owners. The property was acquired after considerable opposition on the part of the owners and several condemnation proceedings, and the yard is now completed and in operation.

The arrangement of the yard is shown on the lower part of Plate CXXVI. It is divided into three distinct sections: The electric interchange yard; the west-bound classification and east-bound receiving yard; and the east-bound classification and west-bound receiving yards. As a yard, it is modern in every respect, with a west-bound capacity of about 2 200 cars and an east-bound capacity of 3 000 cars. This does not include the electric receiving and delivering tracks, which provide for the handling of the business of foreign roads as well as that of the Michigan Central traffic.

A new passenger station is being built in Windsor, east of the summit of grade of the tunnel, at the location shown on Fig. 2.

In Detroit the present arrangement of the tracks of the various railroads is such that any railroad can enter the new station over existing tracks. In Windsor it will be necessary to build a line connecting the several railroads. Such a line has been built connecting the Grand Trunk and the Michigan Central, which can be made to serve the Canadian Pacific and Pere Marquette also, thus providing an entrance to the tunnel for all the railroads.

Conclusion.

It has been mentioned that the contract for the construction of all sections of the tunnel, exclusive of the electrification and certain work of minor importance performed by the Tunnel Company, was awarded to the Butler Brothers-Hoff Company. The corporate name of this company was changed during the progress of the work to Butler Brothers Construction Company, Olaf Hoff, M. Am. Soc. C. E., retiring from the firm.

The construction contract was completed on July 1st, 1910, and the electrification work was so well in hand that the first train drawn by an electric locomotive passed through the tunnel on July 26th, 1910. Some little delay was suffered in the formal opening of the tunnel, due to terminal work in Detroit, but freight-train operations were started on September 15th, 1910, and the tunnel was opened for all classes of traffic a month later.

It is of more than passing interest and importance to record that the controlling lever of the electric locomotive used for the initial train movement through the tunnel was in the hands of Mr. Henry B. Ledyard. To Mr. Ledyard, more than to any one man, is due the credit for the existence of this structure, forming, as it does, a most important all-rail connection between the United States and Canada, and, what is of vastly greater importance to the commercial world, an all-rail connection between two parts of a great railroad system. Due to Mr. Ledyard's persistent and untiring efforts during the early stages of the river-crossing problem, and later his unqualified endorsement of a recommended method of tunnel construction, novel and untried, pages may be added to engineering history.

It is with a sense of great obligation that the writer takes advantage of this opportunity to express his appreciation of the wise counsel and judgment of Messrs. Wilgus and Carson.

The contract was unique, particularly with reference to the subaqueous section, leaving the working out of details to the ingenuity of the contractor. The ability, energy, and resourcefulness of the contractor, as concentrated in the representative in immediate charge of the work, Mr. William Butler, was a source of constant gratification.

An able and loyal staff of assistants was found in Messrs. Benjamin Douglas, M. Am. Soc. C. E., J. C. Mock, A. C. Everham, Assoc. M. Am. Soc. C. E., William Burton, Assoc. M. Am. Soc. C. E., J. M. Hammond, and E. M. Walker, Assoc. M. Am. Soc. C. E., all of whom remained until the completion of the work.

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AMERICAN SOCIETY OF CIVIL ENGINEERS
INSTITUTED 1852

PAPERS AND DISCUSSIONS

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THE PRESENT-DAY PUMPING ENGINE FOR WATER-WORKS.

Discussion.*

By Messrs. John H. Gregory, Charles B. Buerger, George A. Orrok, and Kenneth Allen.

Mr. Gregory. John H. Gregory, M. Am. Soc. C. E.—The author has presented an admirable paper on a subject which is of great interest, not only to water-works engineers who are engaged in operating works, but also to those who are called on to design them. It is to be regretted that he has confined his text to the consideration of pumping engines which serve either to deliver water directly into distribution systems or into distributing reservoirs, and has not discussed the low-lift pump or pumping engine. The demand for water of a higher standard of purity has necessitated, and will still necessitate, the installation of water purification works, and in the majority of such works it is probably safe to say that low-lift pumps will be required; therefore a discussion of the low-lift pump or pumping engine, especially of the centrifugal pump operated by steam, electric, or water power, would be welcome.

The author has given some good general figures as to the cost of various types of pumping engines complete, with foundations, piping, and appurtenances. That high-duty, vertical, triple-expansion, condensing pumping engines, under the conditions stated by Mr. Hague, have been installed at a cost of $4 800 per million gallons per 24 hours, the speaker does not question, but he is inclined to believe that, for a general average, the figure stated is a little low. Table 3 gives the cost

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* This discussion (of the paper by the late Charles Arthur Hague, M. Am. Soc. C. E., published in *Proceedings* for March, 1911, and presented at the meeting of May 17th, 1911), is printed in *Proceedings* in order that the views expressed may be brought before all members for further discussion.

Mr. Gregory.

of pumping stations complete, including reserve, equipped with pumping engines of this type. The value of this table would be materially increased by the addition of another column giving the percentages of reserve allowed for. The amount of reserve will vary greatly, depending on the capacity of the pumping station. For example, with a net capacity of 20 000 000 gal. per 24 hours, two 20 000 000-gal. pumping engines might be installed, in which case the reserve would be 100 per cent. With a much larger station, having a net capacity of, say, 100 000 000 gal. per 24 hours, a reasonable installation would include six 20 000 000-gal. pumping engines, five in service and one in reserve; in which case the reserve would be only 20 per cent.

The author's comments on the steam turbine and centrifugal pump are interesting. That the high-duty, vertical, triple-expansion, pumping engine, with its high first cost and great efficiency, is here to stay, is hardly to be questioned; but the speaker believes, also, that there is a field for the less costly and less efficient turbine-operated centrifugal pump. It is probably safe to say that, at present, in most cases, preference would be given to the vertical, triple-expansion, pumping engine, but it is not hard to conceive of conditions under which it might be more desirable to install the turbine-operated centrifugal pump, especially where the cost of coal is very low. As bearing on the cost of such a pump, the following figures, given to the speaker by the engineer who installed the work, may be of interest: The unit consists of a single-stage, centrifugal pump and a 2 500-h.p., steam turbine (operating under superheated steam), with a speed of 15 000 rev. per min.; and has a capacity of 18 000 000 gal. per 24 hours against a head of 405 ft. The unit cost was $50 000, and the duty developed was 110 000 000 ft-lb. per 1 000 lb. of steam. The speaker understands that the unit has been in service about two years, and that its operation has been satisfactory. As to whether this installation will prove to be a good paying investment in the long run, time alone will tell.

Mr. Buerger.

Charles B. Buerger, Assoc. M. Am. Soc. C. E. (by letter).—The following remarks may be of interest in amplification of Mr. Hague's very able résumé of pumping engines.

The duty record, as given in Table 2, stopping at 1906, will, if brought up to date, show some improvement achieved since that time:

1906: Allis Chalmers, triple-expansion, vertical engine, for the Hackensack Water Co., at the Milford, N. J., station.—Rated capacity = 12 000 000 gal. per day; stroke = 48 in.; speed = 25.45 rev. per min.; steam pressure = 176.67 lb., gauge; water pressure = 334.75 ft.; cylinder diameters = 30, 54, and 84 in.; plunger diameter = 26 in.; duty per 1 000 lb. of dry steam = 181 433 826 ft-lb.

1909: Holly, triple-expansion, vertical engine, for the City of Albany, N. Y.—Rated capacity = 12 000 000 gal. per day; stroke = 60

Mr. Buerger. in.; cylinder diameters = 28, 54, and 80 in.; plunger diameter = 25 in.; speed = 22.14 rev. per min.; steam pressure = 153.56 lb., gauge; exhaust pressure = 3.24 in. of mercury, absolute; water pressure = 322.21 ft.; duty per 1 000 lb. of dry steam = 182 281 000 ft-lb.

1910: Holly, triple-expansion, vertical engine, for the City of Philadelphia, Pa.—Rated capacity = 20 000 000 gal. per day; stroke = 66 in.; cylinder diameters = 30, 60, and 90 in.; plunger diameter = 33 in.; speed = 20.13 rev. per min.; steam pressure = 180.19 lb., gauge; exhaust pressure = 2.52 in. of mercury, absolute; water pressure = 220.85 ft.; duty per 1 000 lb. of dry steam = 184 476 000 ft-lb.

Mr. Hague hardly does justice to the possibilities of the turbine-driven centrifugal pump. It is true, as he says, that it has not established itself as a competitor on equal terms with the high-grade reciprocating engine for all conditions of service, but it has earned a sufficient place to require its serious consideration for any particular installation, and in many cases it will be found that the turbine pump unit will show the best ultimate economy, when combining with the operating charges the fixed charges on the investment.

A comparison of the two types of installation under the same conditions of service will illustrate this statement. It is assumed in this comparison that the service is such that the pumps can operate at their full rated capacity when working, and against their rated pressure.

Capacity of pump = 10 000 000 gal. per day; water pressure = 207 ft.; steam pressure = 150 lb., gauge; vacuum, supplied with pump.

The pumping engine is assumed to be in operation 80% of the total time during the year. It is probable that, in the average installation of pumping stations, the delivered capacity is considerably less than 80% of the rated capacity of the station, and this assumption is somewhat in favor of the pump with the higher steam economy and higher first cost.

(*a*) Triple-expansion, vertical, single-acting engine;
48-in. stroke; 25 rev. per min.

Cost, installed, including foundations and appurtenances, from Mr. Hague's Table 2 = $50 000; engine floor space = 18 by 40 ft.; engine height = 40 ft.; engine-room floor space = 38 by 60 ft.; building height, allowing space for crane = 53 ft.; building contents for each engine = 120 000 cu. ft.; engine-room cost = $24 000; duty guaranteed by builder = 160 000 000 ft-lb. per 1 000 lb. of dry steam; average operating duty, assumed at 20% less than guaranteed duty, or 128 000 000 ft-lb. per 1 000 lb. of dry steam. (The test duty would exceed the guaranteed duty by 5 per cent.) Dry steam to engine per day = 134 000 lb.; allowance for auxiliaries and losses (10%) = 13 400 lb.; boiler-horse-power developed = 205; average boiler-horse-power required at 80% operation = 164; assumed total cost of steam, allowing for fixed charges $50 per horse-power per year: Total steam cost per year = $8 200; boiler capacity installed = 200 h.p.; cost of boiler-room = $6 000.

Charges against engine per year: Interest = 4%; sinking fund, based on a life of 20 years and a 2% return on the sinking fund = 4%; maintenance and supplies, not including operating labor = 4%; total = 12 per cent.

Charges against buildings: Interest = 4%; sinking fund, based on a life of 30 years and 2% return = 2½%; maintenance = 1%; total = 7½ per cent.

Yearly charges against reciprocating engine plant:

Engine = 12% on $50 000	$6 000
Buildings = 7½% on $30 000	2 250
Steam charges =	8 200
Total	$16 450

(*b*) Compare with a turbine pump unit installation of the Delaval type, of the same size, and running under the same conditions.

Cost, installed with appurtenances = $20 000; floor plan = 15 by 25 ft.; height of pump = 10 ft.; building space = 27 by 37 ft.; building height = 25 ft.; engine-room contents = 25 000 cu. ft.; engine-room cost = $5 000; duty guaranteed by builder = 100 000 000 ft-lb. per 1 000 lb. of dry steam; average operating duty, assumed at 20% less than the guaranteed duty, or 80 000 000 ft-lb. per 1 000 lb. of dry steam; dry steam per day of full operation = 215 000 lb.; corresponding boiler capacity = 298 h.p.; allowance for auxiliaries and losses = 10%; total boiler capacity developed for full operation = 328 h.p.; average boiler capacity developed on 80% basis = 262 h.p.; yearly steam charges at $50 per h.p. = $13 120; boiler capacity installed = 450 h.p.; boiler-room cost = $9 000.

Yearly charges against turbine plant:

Pump unit = 12% on $20 000	$2 400
Building charges = 7½% on $14 000	1 050
Steam charges =	13 120
Total	$16 570

These figures seem to indicate that the more economical type of turbine centrifugal pump can sometimes meet the high-grade reciprocating pump. It is not possible to draw any general conclusions, however, from such a particular example.

Mr. Hague, in his discussion of the centrifugal pump, has fallen into an error in the statement that the attempt to meet the high speed of the steam turbine by reducing the diameter of the pump runner

Mr. Buerger. results in a loss of mechanical efficiency, as against a larger pump at a lower rotative speed. The correct relation is that the higher the rotative speed and the smaller the impeller diameter the greater will be the mechanical efficiency. The only limitation is that the impeller must be somewhat larger in diameter than the suction opening required.

In considering the benefit of superheat, Mr. Hague credits a fuel economy of from 6 to 12% to superheating. When used in connection with engines of the type taken by Mr. Hague in his comparison, such as the Chestnut Hill high-service engine, it is probable that 6% is the upper limit of the fuel economy that can be expected.

The most satisfactory published trials of superheated steam in efficient pumping engines are those of 1908 of the Camden Iron Works engines at the River Station in Cincinnati.

The main features of these trials are as follows: Rated capacity = 30 000 000 gal. per day; water pressure = 140 ft.; cylinder diameters = 29, 54, and 82 in.; stroke = 96 in.; plunger diameter = 37½ in.; speed = 15½ rev. per min.

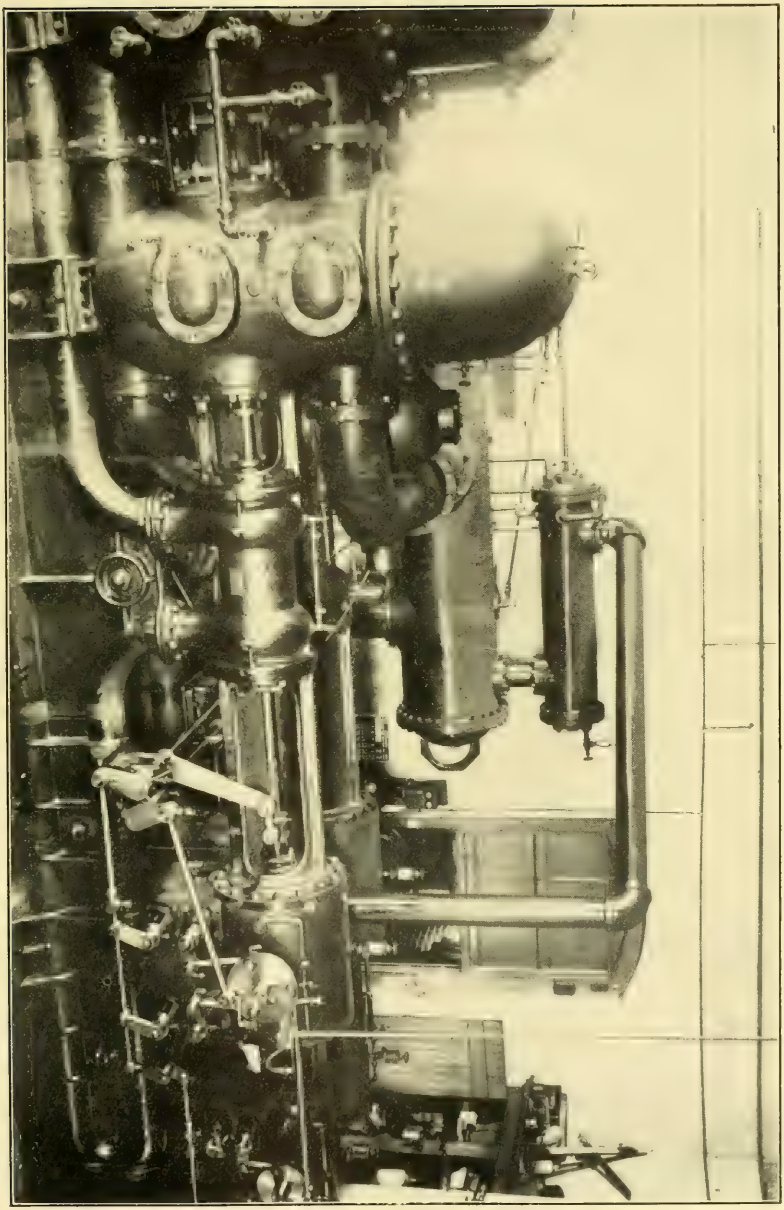
No. 3 engine was tested with both saturated and superheated steam, with the following results:

	Saturated.	Superheated.
Steam pressure, gauge........	151.4 lb.	148.9 lb.
Superheat at engine...........	......	95.8°
Vacuum, in pounds...........	13.81	14.1
Duty, per 1 000 000 B. t. u., in millions of foot-pounds.....	154.6	163.
Increase in duty.............	......	5.44%
Duty per 100 lb. of coal, in millions of foot-pounds....	156.3	166.4
Correction for boiler plant operation	......	4.34%
Increase in engine efficiency, fuel basis..................	......	6.15%

With engines such as the Philadelphia engine noted before, which, with saturated steam, shows a duty of 163 330 000 ft-lb. per 1 000 000 B. t. u., which is as high as this Cincinnati engine with superheat, the probable gain from superheating would be less than the amount shown by these tests.

Mr. Orrok. GEORGE A. ORROK, M. AM. SOC. C. E.—The speaker's acquaintance with water-works pumping engines is small, but a word must be spoken for the turbine-driven centrifugal pump, which is commencing to come into vogue. The capacity of the pump the speaker has in mind was 1 000 gal. per min. (1 440 000 gal. per 24 hours) against a head of 700 ft. Its guaranteed efficiency was 65 per cent. Under service conditions, an efficiency of 68% was obtained. The pump was driven

PLATE CXXVII.
PAPERS, AM. SOC. C. E.
AUGUST, 1911.
ALLEN ON
WATER-WORKS PUMPING ENGINES.



D'AURIA PUMPING ENGINE, WITH COMPENSATING DEVICE.

Mr. Orrok.

by a turbine, running non-condensing, at 1 650 rev. per min. The turbine used about 33 lb. of steam per b.h.p. The duty per 1 000 lb. of steam was about 40 000 000 ft-lb.

With careful design and good construction, the centrifugal pump will develop an efficiency as high as 75 or 80%, say, 78%, as a fair limit, with speeds for turbine drive of from 2 000 to 2 500 rev. per min. A well-designed condensing turbine, at these speeds and in the sizes from 500 to 2 000 b.h.p., should develop 1 b.h.p. for 9 lb. of steam or less, and the duty of such an outfit would be about 170 000 000 ft-lb. per 1 000 lb. of steam.

The feed-pump referred to above occupied a space of 15 by 3 by 3 ft., and had five stages for 700 ft. head. To-day such a pump would have only two stages, would be 2 ft. shorter, and 1 or 2% more efficient.

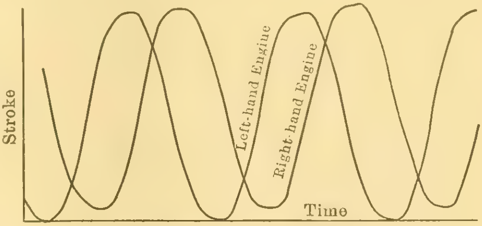
A 20 000 000-gal. pump, for heads between 300 and 400 ft. would be approximately 18 ft. long, and probably not more than 5 ft. in diameter.

The good turbine efficiency mentioned above is attained now by practically all makers.

Mr. Allen.

Kenneth Allen, M. Am. Soc. C. E.—Would not the combination of a gas engine operating triplex pumps through eccentrics on the main shaft be a good one for accommodating the high engine speed to the reciprocating motion of the plunger?

The compensating device of the d'Auria pump is an interesting and valuable feature which probably has not received the recognition it deserves. This, as mentioned by the author, consists in an oscillating column of water actuated by a plunger inserted between the steam and water cylinders. This responds promptly, automatically, and to the degree necessary to prevent any sudden or material variation of speed due to change of load.



Velocity Diagram of D'Auria Pump

Water Pressure 46 Lb. per Sq. In.
Steam " 82 " " " "
Revolutions per Minute 72

Fig. 1.

A speed diagram (Fig. 1), taken from the motion of the piston of a d'Auria pump at Atlantic City, shows a remarkably smooth variation of velocity at all parts of the stroke, with no stop at the end, such as usually occurs with direct-acting pumping engines of this type.

This pump was built by the I. P. Morris Co., of Philadelphia, after designs by the inventor, Mr. Luigi d'Auria, and was the second of

Mr. Allen. the kind built, the first being for the Philadelphia Water Department. It was placed in service on January 1st, 1902. On January 29th, 1903, a 10-hour test was made by the speaker in which the duty developed was 73 679 000 ft-lb. per 1 000 lb. of commercially dry steam, the capacity shown being 3 411 000 gal. per day with steam at 88.6 lb. pressure and a total lift, including suction, of 119.06 ft. The efficiency of the steam end was 85.4%; of the water end 93.6%, and of the two combined, 80.0 per cent. These results were probably fair, considering the small size of the pump and the low steam pressure, but have doubtless been exceeded in more recent plants.

Soon after this pump was put into commission a blank flange on the 20-in. force-main blew off, resulting in a sudden drop in the water pressure such as would have caused a dangerous increase in the speed and stroke of an ordinary duplex pump. In this case the adjustment to the situation was prompt, easy, and effective, with no damage to the pump.

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AMERICAN SOCIETY OF CIVIL ENGINEERS
INSTITUTED 1852

PAPERS AND DISCUSSIONS

This Society is not responsible for any statement made or opinion expressed in its publications.

TWO EARTH DAMS OF THE UNITED STATES RECLAMATION SERVICE.

Discussion.*

By James Dix Schuyler, M. Am. Soc. C. E.

Mr. Schuyler.

James Dix Schuyler, M. Am. Soc. C. E. (by letter).—This paper is a timely and interesting account of the construction of two earth dams, under somewhat unusual and rather difficult conditions, by distinctly different methods, and the facts presented add most acceptably to the sum of engineering experience in such constructions. It is to be hoped that all Engineers of the U. S. Reclamation Service who have had charge of building dams will confer a similar favor on the Profession by publishing in detail the results achieved on works of such magnitude, carried out under the wide range of conditions which the Western field presents.

The author compares the building of earth dams by the old-fashioned mechanical means of delivering, spreading, sprinkling, and rolling the earth, with the more recently developed method, which involves the use of water as the principal agent for transporting, sorting, and consolidating the mass; and apparently draws conclusions which are not altogether favorable to the hydraulic method. The writer cannot subscribe to these conclusions, as he does not feel that they can be fairly drawn, at least from the experience in the cases cited. The cost per cubic yard of material in the Cold Springs Dam, placed by mechanical means, is given at 43 cents, which is sufficiently below the average of such work elsewhere to indicate that it was managed with economy, skill, and care. The average cost per cubic yard of material

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* This discussion (of the paper by D. C. Henny, M. Am. Soc. C. E., published in *Proceedings* for April, 1911, and presented at the meeting of June 7th, 1911), is printed in *Proceedings* in order that the views expressed may be brought before all members for further discussion.

Mr. Schuyler.

placed by the hydraulic method in the Conconully Dam is stated to have been 50.8 cents, which is so much higher than such construction should ordinarily cost, that it seems to indicate exceptionally difficult conditions, or lack of experience, or both. The author is fair enough to admit that

> "There can be little question that the construction at Conconully, under the existing conditions, would have been higher in cost if any other than the hydraulic method had been used."

This admission covers one of the most important of the advantages presented by the hydraulic system of dam building, as it frequently offers the opportunity of accomplishing results, such as were attained at Conconully, where other methods would have failed or have been prohibitive in cost. This being true, as appears to have been demonstrated at Conconully Dam, the merits of the hydraulic method are certain to become more conspicuous as experience develops the best standards of working.

Conditions at Conconully were evidently extremely unfavorable for economical or efficient operation of the system, and it cannot be taken as a criterion from which to judge the merits of the hydraulic-fill process of dam building. A dam, the total volume of which is only 351 500 cu. yd., but which required a plant costing $71 200, with a scrap value of only $2 105 when the work was finished, apparently presents extremely difficult conditions or shows inexperienced management. It is rather remarkable that more than 20% of the cost of hydraulicking is represented by the items of "Superintendence, Administration, Engineering, and General Expenses"—items which are usually amply covered by the ordinary 10% of engineers' estimates for "Superintendence and Engineering."

It is evident that the attempt to place the impervious core material farther up stream than the center of the dam, where it has been located in all other hydraulic-fill dams of which the writer has knowledge, the sheet-piling cut-off having been located 70 ft. above the center line, resulting in the necessity for inclining the plane of the core, and confining it between inclined board forms, added very largely to the cost and difficulty of building the dam, especially as the core material for its upper part was handled by scrapers from the valley borrow-pits. From the description of all the materials available, and from the plans and photographs submitted, the writer believes that the work could have been simplified and cheapened by the following modifications:

First.—By providing a larger water supply at the outset, instead of working a whole year with an inadequate volume, to move, on the flat gradients chosen for the flumes, the angular rock which the borrow-pits yielded.

Mr. Schuyler.

Second.—By building the flumes for delivery of material on minimum grades of 6%, instead of 4%—8% would have been better.

Third.—By building the bulk of the dam as a simple embankment, without attempting to segregate the material further than necessary to prevent waste by providing for the settlement of the fines in a pond between levees, but filling this pond periodically and systematically with rock, sand, gravel, and clay, the run of the pit.

Fourth.—By depositing a heavy, impervious blanket, of selected fine material from the valley borrow-pits, on the up-stream face of the main embankment previously built as suggested, this blanket to serve as a water-tight cover for the dam, already well consolidated by the water and the ramming impact of material dropping from the flumes. It would preferably be considerably thicker at the bottom than at the top, as it should have a flatter slope on the water side than the rock. This water-tight facing, as a substitute for the central core, apparently could have been handled more cheaply by a hydraulic elevator, as there was sufficient available head in the flume to serve the purpose, for at least two-thirds the entire height.

The suggested plan of working would have made the dam practically a rock-fill structure with earth facing, similar to the Milner and Minidoka Dams, on Snake River, Idaho, the Zuñi Dam, in New Mexico, and the Clear Lake Dam of the Klamath Project.

The author has fairly stated the principal factors which require careful consideration when the application of the hydraulic method to earth-dam construction is proposed. The most ardent advocates of the method have never claimed that it could be made applicable to every condition, that it was automatic in its action, or that it required any less intelligence and watchful care, skill, and experience to produce the best results. What is specially true of the hydraulic method, however, is that where it is applicable, and skillfully used, it will frequently give cheaper results and better dams, and, therefore, is worthy of consideration at all times, and in every case. Even though the material may be excavated by steam shovel and delivered by cars to the dam, sluicing may often be used to advantage for segregating the fine from the coarse to secure water-tight material for the core, as was done at the Arrowhead Dam, in California, and the Willow Creek Dam, in Oregon. Undoubtedly there are many cases where sluicing can be used to better advantage than the mechanical process, and at much less cost, and not infrequently it can be used to build a high-class dam where it would have been absolutely impracticable to build a safe structure by any other method. In the writer's opinion the great Gatun Dam, by far the largest in the world, in which the bulk of the material is being handled satisfactorily by hydraulic dredges, could not have been built so well, so cheaply, or so rapidly, by the

Mr. chuyler. ordinary dry mechanical means. Some years ago a dam was built on the site of James Peak, in Colorado, at an altitude of more than 10 000 ft., where the material had to be sluiced out from between boulders so large and numerous as to have made it impossible, or impracticable, to select and segregate what was required by any mechanical means.

One of the special features of interest in the paper is the description of the foundation which "could not be made water-tight," and the use of sheet-piling, driven 33 ft. into the alluvial soil of the valley, simply to "retard percolation" and to discourage seepage by increasing the length of its path from the reservoir to the exit below the dam. The amount of settlement of the dam into its unstable alluvial foundation, due to a compacting of the fine loamy sand, to the extent of 3 or 4 ft., is rather extraordinary and unusual, and further illustrates the difficulties of the situation. The future history of this structure will be instructive and interesting, and if it endures the test of time and satisfactorily performs its functions, it will establish a valuable precedent and extend the range of feasibility in dam construction.

The absence of core-walls from five of the seven earth dams built by the U. S. Reclamation Service, cited in the paper, other than the two described, is evidence of an inclination on the part of the engineers in charge to depart from the hidebound Eastern American practice of using core-walls of masonry or concrete, which are so frequently an element of weakness rather than of service in promoting water-tightness.

The writer feels greatly indebted to the author for the clear presentation of his experiences and opinions, but hopes that his future experience with the hydraulic process may lead to additional illumination of a subject which is still somewhat obscure in the minds of the majority.

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PAPERS AND DISCUSSIONS

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STEEL CENTERING USED IN THE CONSTRUCTION OF THE ROCKY RIVER BRIDGE, CLEVELAND, OHIO.

Discussion.*

By L. J. Mensch, M. Am. Soc. C. E.

L. J. Mensch, M. Am. Soc. C. E. (by letter).—The three-hinged arch centering described by Mr. Watson is an interesting form of scientific centering for concrete construction. In 1898 the writer designed three-hinged steel arches of 51-ft. span for the arching of the River Wien at Vienna, Austria.* About 100 arches were used, as they were cheaper than timber centering on account of the high price of timber. These arches were figured for the radial component of the load only, just as Mr. Watson's were, and the deflection was obtained by the graphical method, according to Williot. The writer seriously doubts, however, whether the steel centering used for the Cleveland bridge was cheaper than a scientifically designed timber centering would have been. The steel centering simply replaced the wooden supports holding the timber lagging in place, and it would hardly have taken more than 400 000 ft. b. m. for the necessary supports, bracing, and pilings, for both portions of the arch. Mr. Mensch.

From the paper it appears that the cost of the steel centering, after allowing for the steel I-beams and scrap material, was $17 200, which with incidentals was easily brought up to $20 000. The cost of 400 000 ft. of timber, erected and dismantled, would have been considerably less than $20 000, especially as there was time to wait for

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* This discussion (of the paper by Wilbur J. Watson, M. Am. Soc. C. E., published in *Proceedings* for April, 1911, and presented at the meeting of June 7th, 1911) is printed in *Proceedings* in order that the views expressed may be brought before all members for further discussion.

* *Engineering* (London), Vol. LXVIII, p. 325 (Sept. 15th, 1899).

Mr. Iensch. the shipment of lumber from the South, and considering that the value of the old material to the contractor would have been a large percentage of the original cost.

In 1906 steel centering was used for a reinforced concrete bridge of 140 ft. span and 23 ft. rise, at Deurne-Merxem, France. It consisted of an iron trestle with steel supports about 8 ft. apart in the direction of the bridge and 6 ft. apart crossways, leaving a clear waterway, 32 ft. wide, in the center, which was spanned by an arched box section consisting of two 12-in. channels and 10 by $\frac{1}{4}$-in. cover-plates. The supports consisted of two angle irons varying from 2 by 2 by $\frac{1}{4}$ in. to $2\frac{1}{2}$ by $2\frac{1}{2}$ by $\frac{5}{16}$ in.

It would be interesting to learn how the shrinkage of the rich concrete in Key *A* was overcome, so that the contact of the surface with the next higher voussoir was preserved in every point.

The writer is rather surprised at the author's statement that reinforced concrete arches of spans like that of the Cleveland bridge are impracticable,

> "because the live load is practically negligible in comparison with the dead load, and the curve of the arch can be adapted to the curve of the equilibrium polygon, thus practically eliminating all bending and shearing forces in the arch ring."

An arch bridge can be shaped according to an equilibrium polygon of only one system of loading. Any other system of loading produces bending moments and shearing forces in every point of the arch, and in order to keep these stresses within allowable limits in a solid concrete or masonry arch, the thickness of the arch must be increased beyond economical sizes.

Compare the Cleveland bridge with the design for a reinforced concrete bridge, with a span of 300 ft. and a rise of 90 ft., made by the writer.* The average uniform total dead and live load for which the thrust is to be figured, is given as 3 233 lb. for 6 sq. ft., or the thrust for a span of 280 ft. and a rise of 80 ft. and for a width of 6 ft. of the bridge $= 3\,233 \times \frac{280 \times 280}{8 \times 80} = 396\,000$ lb.

It is also shown† that the greatest moment in an arch of the shape proposed, from a moving uniform load, occurs at a point distant three-tenths of the span from the abutment, and $= \frac{pl^2}{100}$ when p equals the uniform live load per linear foot and l the span in feet. This value is about 12% greater than that commonly found, because ordinarily it is assumed that the greatest moment occurs when exactly half of the span is uniformly loaded, while in reality it is produced when the load

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* "The Reinforced Concrete Pocket Book," p. 178.

† *Ibid*, p. 158.

Mr. Mensch.

covers only $\frac{44}{100}$ of the span. For a 6-ft. width of bridge, $p = 600$ lb. and $l = 280$ ft., and the maximum moment $= \frac{600 \times 280 \times 280}{100} =$ 470 400 ft-lb.

The section, shown by Fig. 3, has an area equivalent to 1 915 sq. in. and a moment of resistance of 17 700 cu. in.; hence the uniform stress produced by the thrust is very closely $\frac{396\,000}{1\,915} = 214$ lb. per sq. in., and the extreme tensile and compressive stresses in the concrete $= \frac{470\,400}{17\,700} = 266$ lb. per sq. in., or the maximum compressive stress $= 214 + 266 = 480$ lb. per sq. in., and the maximum tensile stress $= 266 - 214 = 52$ lb. per sq. in.

All ordinances and safe practice require that tensile stresses in the concrete must be taken care of entirely by the steel reinforcement. In order to satisfy the most timid engineer, it will be assumed that the entire bending moment must be taken up by the reinforcement, neglecting the favorable influence of the thrust of the arch. The area of seven 1½-in. rods is 12.355 sq. in., the distance from center to center of reinforcement is 40 in. or 3.33 ft., and, therefore, the stress in the steel rods from the entire bending moment $= \frac{470\,400}{3.33 \times 12.355} = 11\,450$ lb. per sq. in., which is certainly a conservative figure, if this stress did exist.

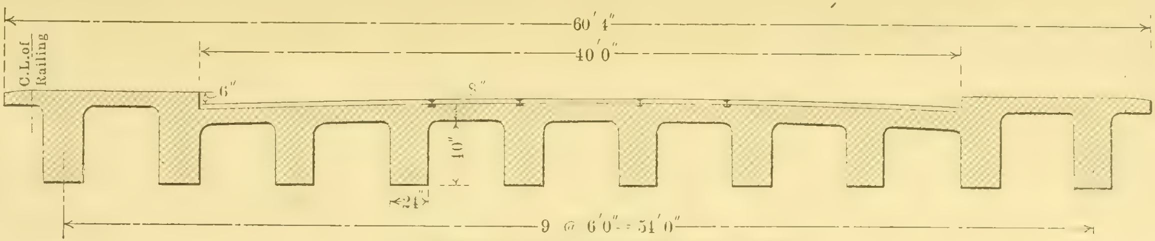
The writer estimates that the greatest tensile stress in the steel rods in this case does not exceed 1 400 lb. per sq. in., and the greatest compressive stress does not exceed 7 000 lb. per sq. in. The temperature stresses for the change of 50° Fahr., do not amount to more than 25 lb. per sq. in. and, therefore, are negligible.

This calculation assumes that the section shown by Fig. 3 is at the three-tenths point of the arch. The writer has advised that this section be used as the crown section, gradually increasing it 50% until it reaches the abutment, so that the actual stresses are easily 20% smaller than those already given.

The weight of the reinforced arch for which the centering must be figured is only 250 lb. per sq. ft., as against 600 lb. in the Cleveland bridge, and we can expect that three-hinged steel arches for the centering of the reinforced concrete arch cost one-half of that of the Cleveland bridge.

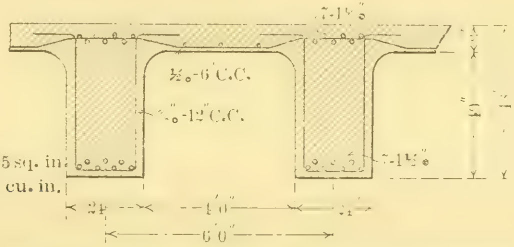
It is possible to go still further, and instead of round bars for reinforcing the arch ribs, a latticed arch rib without hinges, as shown by Fig. 4, may be used. This may be designed to carry the dead load of the concrete ribs, and to take up the tensile and compressive stresses previously mentioned.

Mr. Mensch.



Crown Section of Reinforced Concrete Bridge of 280' Span and 80' Rise.

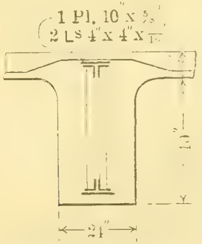
FIG. 2.



Area of 6' Section = 1536 sq. in.
" " 6' Section including
15 times Area of Reinforcement 1915 sq. in.
Least Moment of Resistance = 17700 cu. in.

Section of 6 Ft. Width of Bridge, Showing Reinforcement.

FIG. 3.



Section of Latticed Arch Rib without Hinges.

FIG. 4.

Mr. Mensch.

The writer* has found that the maximum bending moment in the steel ribs from a symmetrical application of the dead load $= 0.0045\ pl^2$, and occurs at the crown, when 0.37 of the span is loaded at each end of the arch. In this case the thrust $= 0.0676\ \frac{pl^2}{f}$, when f = rise in feet.

It will be advisable to concrete two arch ribs on one day and the slabs on the following working day. Let $p = 1\,000$ lb., and the maximum moment $= 0.0045 \times 1\,000 \times 280^2 = 353\,000$ ft-lb., and the corresponding thrust $= 0.0676\ \frac{1\,000 \times 280^2}{80} = 66\,300$ lb. Assuming that the theoretical depth of the latticed arch ribs = 3.33 ft. and the sectional area of one chord = 14 sq. in., it will be found that the extreme stresses from the bending moment $= \frac{353\,000}{14 \times 3.33} = 7\,560$ lb. per sq. in., and from the thrust $= \frac{66\,300}{28} = 2\,370$ lb., or the maximum compressive stress $= 7\,560 + 2\,370 = 9\,930$ lb. per sq. in., which stress, however, reduces to 4 370 lb. per sq. in. where the entire rib is concreted, and thereby the bending moment is annulled and only direct compression is acting.

The uniform compressive stress will increase to less than 8 000 lb. per sq. in., when the entire slab is concreted on the following day. It has been shown that the greatest stresses in the round steel reinforcement were 7 000 lb. and 1 400 lb. per sq. in. in compression and tension, respectively; adopting the same values for the latticed steel arch, it will be found that the maximum compressive stress equals 15 000 lb. per sq. in., and that no tensile stresses exist in the latticed arch. No claim is made that these stresses are exact, but it can be positively asserted that they are actually very much lower. The writer estimates the weight of nine arch ribs, as outlined, including braces, at 270 tons, and the cost at $22 000, which is practically the cost of the steel arches and wedges of the Cleveland bridge. That the reinforced concrete bridge proper was much cheaper than the solid concrete bridge is apparent from the fact that the yardage of the concrete is only one-third that of a solid concrete bridge.

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* "The Reinforced Concrete Pocket Book," pp. 157-158.

MEMOIRS OF DECEASED MEMBERS.

NOTE.—Memoirs will be reproduced in the volumes of *Transactions*. Any information which will amplify the records as here printed, or correct any errors, should be forwarded to the Secretary prior to the final publication.

OCTAVE CHANUTE, Past-President, Am. Soc. C. E.*

DIED NOVEMBER 23D, 1910.

This memoir records the professional career of an Engineer closely identified for the last sixty years with the development of transportation on land and in the air.

Octave Chanute was born in Paris, France, on February 18th, 1832. His father was Professor of History in the Royal College of France, in Paris, until 1838, when he accepted the appointment of Vice-President of Jefferson College, in the State of Louisiana. He was a resident of Louisiana until 1844, when he removed to New York City and engaged in literary pursuits. His son, Octave, who was six years old when the family came to the United States, completed his education in New York, and became, to use his own expression, thoroughly Americanized.

In 1849, at the age of seventeen, Mr. Chanute started work on the Hudson River Railroad, beginning, as was usual at that day, at the very foot of the ladder. He introduced himself to the Resident Engineer at Sing-Sing and asked for employment. When told that there was no vacancy, he asked for permission to serve without pay as a volunteer Chainman. This was granted somewhat reluctantly, with the result that within two months the young man was put on the payroll at $1.12½ per day, and thought his fortune made; nor was he far wrong, for Mr. Chanute often said that this was the only position he had ever applied for, and that he had been continuously engaged since that time without having had to solicit employment.

He remained with the Hudson River Railroad for four years, until the completion of construction, when he became Division Engineer, at Albany, in charge of terminal facilities and of maintenance of way.

In 1853 immigrants were pouring into Illinois to buy Government lands at $1.25 per acre (which are now selling at more than $50 per acre) and railroad construction was proceeding rapidly. Mr. Chanute went West with the late H. A. Gardner, M. Am. Soc. C. E., his former Chief Engineer on the Hudson River Railroad, and was engaged on the surveys and construction of what is now a portion of the Chicago and Alton Railroad, between Joliet and Bloomington. Before this

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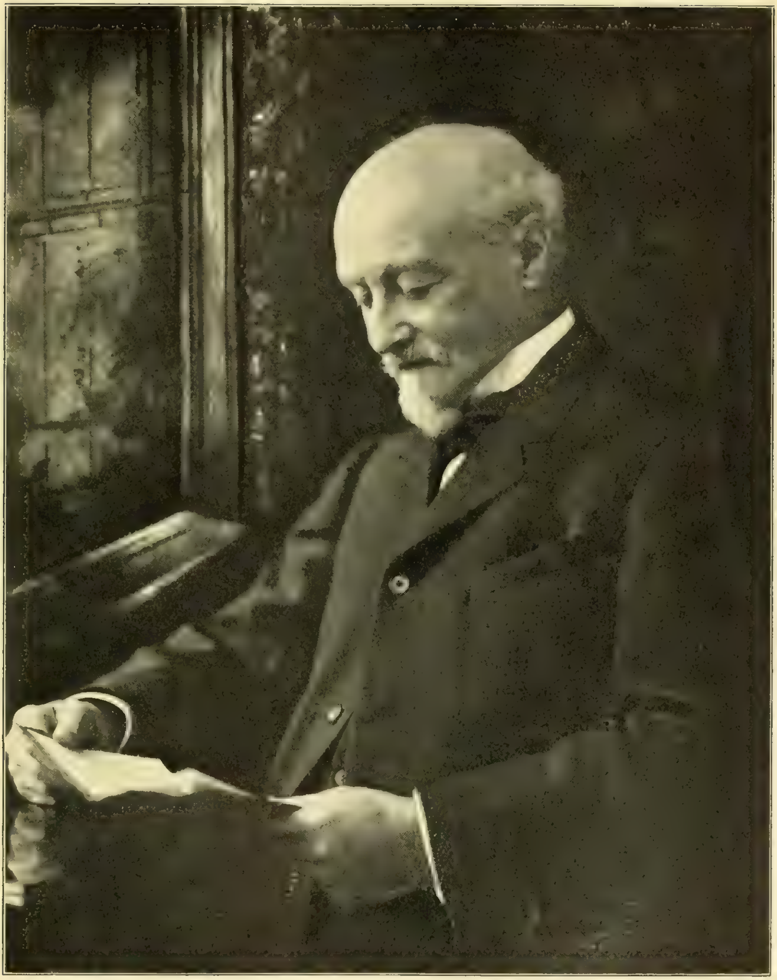
* Memoir prepared by the following Committee: Onward Bates, Past-President, Am. Soc. C. E., Robert W. Hunt, Charles F. Loweth, and Charles L. Strobel, Members, Am. Soc. C. E.



OCTAVE CHANUTE.

work was quite completed, he became Chief Engineer of the eastern portion of what is now the Toledo, Peoria and Western Railroad, and built that road from Peoria to the Indiana State Line, a distance of 112 miles. Upon its completion, in 1857, he remained in charge of maintenance of way until 1861, when, the road having gone into the hands of a Receiver, he accepted the position of Division Engineer of Maintenance of Way of the Pittsburgh, Fort Wayne and Chicago Railroad, between Chicago and Fort Wayne. This appointment was given him by his old friend and Chief, Mr. Gardner, who one year later recommended him for the position of Chief Engineer of the reconstruction and maintenance of the Western Division of the Ohio and Mississippi Railroad, from St. Louis to Vincennes. This he accepted, but six months later the road changed hands, by one of those sudden vicissitudes not uncommon in those days, and Mr. Chanute, having by that time attained a reputation for industry, efficiency, and fidelity, received simultaneously several offers of employment. He accepted that of the railroad which he had first served in the West, and, in 1863, became Chief Engineer of the Chicago and Alton Railroad. As such, he took charge of the reconstruction which, by that time, had been found necessary, for these early American railroads were cheaply built. His duties included the maintenance of way and the building of an extension of the line from Alton to St. Louis.

During this connection, which lasted until 1867, Mr. Chanute submitted a competitive design for the Union Stock Yards of Chicago. His design was selected in preference to a score of others, and he was made Chief Engineer of the Yards, supervising their construction, in addition to his railroad duties.

These various engagements brought him in contact with prominent railroad men, and he was next offered the design and construction of the pioneer bridge over the Missouri River at Kansas City. This offer was accepted, and he tendered his resignation as Chief Engineer of the Chicago and Alton Railroad. The Board of Directors, in accepting his resignation, passed a resolution of regret at the severance of his connection with that company. The construction of the Kansas City Bridge, across a stream so rapid, shifting, and ill-reputed as the Missouri River, involved what were, at that time, a number of novel engineering problems. It was completed successfully in July, 1869, and attracted general interest as the first bridge built over the Missouri River. An account of the construction of the Kansas City Bridge was written by Mr. Chanute and the late George S. Morison, Past-President, Am. Soc. C. E., his Principal Assistant Engineer, and published in 1870.

While engaged in completing the Kansas City Bridge, Mr. Chanute was placed in charge of the building of several railroad lines extending into Kansas, which were planned to secure a portion of the cattle trade coming overland from Texas: The Kansas City, Fort Scott and Memphis Railroad, from Kansas City to the line of the Indian Territory; a parallel line, now known as the Southern Kansas Division of the Atchison, Topeka and Santa Fé Railroad; a connecting line between these two; and a line from Atchison northward, the whole comprising the construction of about 400 miles of railroad, and, incidental thereto, the design and construction of the Union Stock Yards at Kansas City. These various works were completed in 1871, and Mr. Chanute then became General Superintendent of the Southern Kansas Railroad.

In 1873, when the Erie Railroad was reorganized, Mr. Chanute was made Chief Engineer. It was then proposed to double-track this road, to standardize its 6-ft. gauge, to extend the line to New England and to Chicago, and generally to expend about $50 000 000 in improvements. This promised well for the Engineer, but the financial panic of 1873 upset the arrangements made in England for funds. Less than $5 000 000 was expended on the road, which served, however, to double-track the main line, change the gauge to standard, and to improve the gradients so that during the ten years which Mr. Chanute spent on the Erie, the average number of cars in freight trains was increased from 18 to 35. For a time he was in charge of the motive power of the railroad in order to readjust the distribution of locomotives.

Upon his return to New York, in 1873, he observed that "Rapid Transit" in that city had been under discussion for nearly twenty years without any definite results. The necessity for more rapid communication was evident; many projects for superseding horse-cars had been proposed, but none was recognized as solving the problem, and the public seemed to be completely at sea. After some unsatisfactory inquiries as to the reasons for this condition of affairs, Mr. Chanute concluded that the question could be best settled by investigation through a committee of the American Society of Civil Engineers. He was made Chairman of such a committee, consisting of Messrs. W. N. Forney, Ashbel Welch, Charles K. Graham, and Francis Collingwood, which undertook to collect all the data and facts. These were contained chiefly in pamphlets, aggregating about 4 000 pages octavo, and, after this literature had been digested, communications were invited by circular. Five public meetings were held, to give hearings to all who chose to appear, interviews were had with organized bodies and with citizens who were likely to possess information, and a canvass was made of property owners and tenants along the proposed routes.

The resulting report was made public in 1875. It recommended substantially the plan subsequently carried out, that is, the building of four lines of elevated railroads along the avenues, to be operated by steam locomotives, and stated that such lines would be profitable, which was not generally believed by moneyed men at that time. At first, the report was assailed vigorously by men interested in other projects, but the public accepted it, and it was followed almost immediately by the requisite legislation and the building of the roads.

In this investigation, the laboring oars were wielded by Mr. Chanute and Mr. Forney, then Editor of the *Railroad Gazette,* and they wrote the reports and appendices. The former, indeed, had done all his work at night, in order not to interfere with his railroad duties. He found himself so prostrated upon its completion that he had to take a vacation, and he went to Europe for four months to recruit.

In 1880, Mr. Chanute was appointed Chairman of a committee of the American Society of Civil Engineers to report upon wood preservation. The investigation occupied five years, and resulted in the publication of a report of great value, which was the authority on the subject for many years.* In 1885, a number of American railroads called on the Chairman to build plants for wood preservation, and, after that, he became interested in wood preservation as a business.

In 1883, he resigned from the Erie Railroad and removed to Kansas City, opening an office as Consulting Engineer. In this capacity he had charge of the design and construction of the iron bridges of the Chicago, Burlington and Northern Railroad, between Chicago and St. Paul. Later, he performed similar work for the Atchison, Topeka and Santa Fé Railroad on the extension of its line from Kansas City to Chicago, involving, besides a number of minor streams, the bridging of the Missouri River at Sibley and of the Mississippi River at Fort Madison.

As long ago as 1874, Mr. Chanute had become interested in aviation, but it was not until 1889, when he moved to Chicago, and thenceforth made that city his home, that he could find time to devote himself seriously to the solution of this "Problem of the Ages." With characteristic industry and thoroughness he engaged in an extensive correspondence with men all over the world who were interested in this subject, and gathered and systematized all information of importance which he could find, investigating the records of experiments of the past two hundred or three hundred years. The fruit of these labors appeared in a series of articles entitled "Progress in Flying Machines," first published in the *American Engineer and Railroad Journal,* New York (October 1st, 1891, and following issues), and republished in book form in 1894. This publication was of the greatest importance to the advancement of the art, for not only were all experiments of any importance described in detail and the principles elucidated, but the author's opinion on the causes of failure and the probable direction in which improvement might be expected, were stated.

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* *Transactions*, Am. Soc. C. E., Vol. XIV, p. 247.

At about this time Mr. Otto Lilienthal had been making successful gliding experiments near Berlin, and these induced Mr. Chanute to build a Lilienthal glider and to attempt experiments with man-carrying models in continuation of his previous experiments with small models. The site chosen was Dune Park, near the present Town of Gary, on the sand dunes of Indiana. His purpose was mainly to attain equilibrium in the air, and he hoped to accomplish this by adjustments which should be largely automatic. Unlike the unfortunate Lilienthal, who met his death in August, 1896, while making one of his gliding experiments, Mr. Chanute's many experiments—upwards of 200 flights—were free from any misadventure to life or limb. The Lilienthal glider was an unwieldy monoplane, requiring great skill in management. It was soon abandoned and a multiplane glider substituted, and this, in turn, was replaced by the much simpler and more efficient biplane, the prototype of the present Wright aeroplane. These experiments were described by Mr. Chanute in a paper entitled "Gliding Experiments," read October 20th, 1897, before the Western Society of Engineers, and published in its *Journal.**

All these experiments and investigations were made in a genuinely scientific spirit and at his own expense, free to all who were interested, and conducted without any thought of pecuniary or other benefit to himself. He had at an earlier time described his efforts with characteristic modesty as:

> "Giving much of his leisure to the investigation of the chances of success in the possible solution of the problem of Aerial Navigation, not with the expectancy of solving it himself, for he held this would be the work of many men by a gradual process of evolution, but with the hope of advancing the question a little, and making the process easier for those who came after him, by eliminating some of the causes of past failures and laying down the principles which will have to be observed."

On October 20th, 1909, just twelve years after the reading of his first paper on aviation before the Western Society of Engineers, he read his last paper, entitled "Recent Progress in Aviation," in which he described the bewildering record of successful flights which had been achieved, giving a complete chronology of aviation from December 17th, 1903, when the Wrights made the first successful man-flight in history, to October, 1909.

After Mr. Chanute's death, the Aero Club of Washington said of him:

> "Lilienthal, Chanute, Langley, and Maxim are the four names that will ever be inseparably linked with the early stages of flying-machine development, the stages that preceded the successful invention of the first man-carrying machine by the Wright brothers. These four men

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* Vol. II, p. 593.

elevated an inquiry, which for years had been classed with such absurdities as the finding of perpetual motion and the squaring of the circle, to the dignity of a legitimate engineering pursuit."

Mr. Wilbur Wright in "Aeronautics" paid him the following tribute:

"If he had not lived, the entire history of progress in flying would have been other than it has been, for he encouraged not only the Wright brothers to persevere in their experiments, but it was due to his missionary trip to France in 1903 that the Voisins, Bleriot, Farman, De Lagrange, and Archdeacon were led to undertake a revival of aviation studies in that country, after the failure of the efforts of Ader and the French government in 1897 had left everyone in idle despair. Although his experiments in automatic stability did not yield results which the world has yet been able to utilize, his labors had vast influence in bringing about the era of human flight. His 'double-deck' modification of the old Wenham and Stringfellow machines will influence flying-machine design as long as flying machines are made. His writings were so lucid as to provide an intelligent understanding of the nature of the problems of flight to a vast number of persons who would probably never have given the matter study otherwise, and not only by published articles, but by personal correspondence and visitation, he inspired and encouraged to the limits of his ability all who were devoted to the work. His private correspondence with experimenters in all parts of the world was of great volume. No one was too humble to receive a share of his time. In patience and goodness of heart he has rarely been surpassed. Few men were more universally respected and loved."

Mr. Chanute was elected an active member of the Western Society of Engineers on July 12th, 1869; was President in 1901, and was elected an Honorary Member on January 5th, 1909. Some years ago he presented to that Society a fund of $1 000, the interest of which was to provide bronze medals to be awarded annually for the best papers on Civil, Mechanical, and Electrical Engineering subjects. It is noteworthy that the committee to award prizes for papers read to the Society, in 1909, reported, after Mr. Chanute's death, that his paper of October 20th, 1909, on "Recent Progress in Aviation" was the first in merit of all the papers submitted during that year, and the Society presented the medal to his family.

He was elected an Honorary Member of the British Institution of Civil Engineers on May 21st, 1895.

He was an Honorary Member of the Canadian Society of Civil Engineers, a Corresponding Member of the French Society of Civil Engineers, and also of the Chilean Society of Engineers.

He was a Member of the American Railway Engineering Association, the American Institute of Mining Engineers, the Society for the Promotion of Engineering Education, and the American Association for the Advancement of Science.

He was a Fellow of the American Aeronautical Society, an Honorary Member of the Aero Club of America, and was President of the Illinois Aero Club. He was also honored by foreign aero clubs. The Aeronautical Society of Great Britain awarded him a gold medal in recognition of his distinguished services in promoting the art of aviation. He held the degree of Doctor of Engineering from the University of Illinois.

Mr. Chanute was Chairman of the Executive Committee of Engineering Societies which had charge of the International Engineering Congress at the World's Columbian Exhibition in Chicago, in 1893. He was a frequent contributor to the publications of scientific societies and to the various technical journals. A list of the various contributions to engineering literature, prepared by him, begins with his paper on "Pneumatic Bridge Foundation," published in the *Journal* of the Franklin Institute in 1868, and ends with his paper on "The Present Status of Aerial Navigation." This last paper was published in *Science* on December 29th, 1910. This list contains 60 titles, the two principal ones being his books on "The Kansas City Bridge" and "Progress in Flying Machines," which have been referred to.

In his relations with his fellow men, it is sufficient to record that he was unselfish, just, and kind. The present generation needs no eulogy of him, and, for posterity, it may be simply stated that he possessed the qualities of mind and heart which endeared him to his friends, caused those with whom he came in contact to respect and admire him, and which, ripened and chastened by the hard school of experience, produced in him one of our foremost Engineers, whose busy life was rich in works and achievement, and kindly and generous acts, commanding our admiration and prompting our love.

While traveling with his daughters in Europe in the summer of 1910 Mr. Chanute was taken ill with pneumonia. For a time his illness was of so serious a nature that a fatal termination was expected, but he recovered sufficiently to return to America, and, after a lingering illness, died at his home in Chicago, November 23d, 1910. His remains were interred at his old home in Peoria, Ill.

Mr. Chanute was married, in 1857, to Miss Anne Riddell James, of Peoria, Ill., who died in 1902. He is survived by a son and three daughters.

Mr. Chanute was elected a Member of the American Society of Civil Engineers on February 19th, 1868, and a Fellow on July 11th, 1872; he served as a Director for four years (1873-74-75 and 1885), and as Vice-President for two years (1880-81). He was President in 1891, and for the five succeeding years was *ex-officio* a member of the Board of Direction.

ALBERT JOHN SCHERZER, M. Am. Soc. C. E.*

DIED MARCH 3D, 1908.

Albert John Scherzer was born at Annville, Pa., on June 5th, 1848. He was graduated as a Bachelor of Civil Engineering at the Polytechnic College of Philadelphia, in the class of 1866.

Mr. Scherzer commenced his professional career with the Boston, Hartford and Erie Railroad, serving as Rodman and Topographer during 1866 and 1867. In 1868 he was employed as Rodman and Section Engineer on the construction of the Dutchess and Columbia Railroad in New York State. In 1869 he was appointed Topographer and Senior Assistant on Surveys and Location of the Connecticut and Western Railroad, and from 1870 to 1872 was Assistant Engineer of Construction on the same road. During this time Mr. Scherzer served under the celebrated Engineers, the late O. W. Barnes, M. Am. Soc. C. E., of New York, and Mr. W. F. Shunk, of Pennsylvania. He remained a life-long friend of Mr. Shunk who dedicated his well-known field book, entitled, "The Field Engineer," "To His Old Comrade and Dear Friend in Token of Esteem for His Professional Attainments and Respect for his Manly Character."

At about this time Mr. Shunk was offered an important position in Colombia, South America, to take charge of railroad surveys. Being unable to accept the position, he recommended Mr. Scherzer who immediately started for South America to begin his Spanish-American life, and this extended over a period of 36 years.

Soon after his arrival in Colombia Mr. Scherzer was invited to go to Costa Rica, Central America, as Division Engineer of the Atlantic Division of the Costa Rica Railroad. In a short time he was made Chief Engineer and Superintendent of the Division and remained with the road until 1877. There are a number of engineers still living who shared in the hardships and privations encountered in the building of that difficult piece of railroad work.

In 1877 Mr. Scherzer went to Guatemala, Central America, as Chief Engineer and General Superintendent on Surveys, Construction and Operation, of the Guatemala Central Railroads, running from the port San José to Escuintla, thirty miles inland.

During the construction of this branch Mr. Scherzer kept parties in the field for the extension of the road to Guatemala City, the capital of the Republic, a distance of forty miles, which road was built on the lines located by his surveys.

Mr. Scherzer remained in Guatemala until 1882, when he became associated with the railways of Salvador, Central America, as Chief

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* Memoir prepared by Franklin A. Snow, M. Am. Soc. C. E.

Engineer and Contractor. This line began at the Pacific Port of Acajutla and extended inland 12½ miles to Sonsonate. It was the beginning of steam railroads in the Republic of Salvador, and it was there that the writer first met Mr. Scherzer and remained with him for six years on the surveys and construction of the railroad to Sonsonate and its extension to Santa Ana, sixty-four miles inland.

Mr. Scherzer was a most careful and painstaking engineer, and his maps and notebooks were works of art. When the Intercontinental Railway Commission was making surveys for railroads to connect the United States with South America through Central America, all Mr. Scherzer's railroad plans for both Guatemala and Salvador were incorporated, and as separate maps they can be seen among the numerous sheets embodied in those extensive surveys.

Due credit was given him by the engineers in charge of the work, as shown in the following quotation:*

"At Santa Ana, Salvador, it was our good fortune to fall in with our countryman, A. J. Scherzer, Esq., whose reputation as a skillful and successful railroad engineer has extended all through Central America. He offered us freely and without reserve all the information at hand concerning the railroad work on which he was engaged, and later sent to Washington complete plans and profiles showing the *location* of the Santa Ana Railway as now built, enabling Mr. Anton Karl to prepare Map IX, which shows the line as now operated and its connection with our own surveys. I take this opportunity of extending to Mr. Scherzer my thanks for the information given and for hospitalities tendered myself and other members of our party during our stay in Santa Ana."

On page 125, of the Report in reference to the Santa Ana Railway, it is stated:

"This was not an easy road to construct; on the contrary, careful study and skillful engineering were required to successfully overcome topographical difficulties; nor was it an easy matter to secure the necessary capital, the unsettled state of affairs in Central America making foreign investors reluctant to risk their money even in enterprises known, in themselves, to be meritorious and profitable.

"But Santa Ana was fortunate in possessing as a resident Mr. A. J. Scherzer, who by his energy, technical training, wide experience as a contractor, thorough acquaintance with the Central American people, and general knowledge of affairs, was able to fill the complex rôle of grantee, engineer, contractor, and financier, and by patient perserverance to push the work to a successful conclusion, * * * the Santa Ana Railway was thrown open to traffic July 27th, 1896, amid much rejoicing * * *."

Mr. Scherzer was General Manager of the Salvador Railways until May, 1906, when, owing to his ill health, he was compelled to resign.

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* "Report of Surveys and Explorations Made by Corps No. 1, Intercontinental Railway Commission," Vol. 1, Pt. II, p. 7.

He remained in Salvador until 1907, during which time he surveyed and built the branch road running from Sitio del Niño to San Salvador, the capital of the Republic. He was also interested personally and financially in the building of the Sonsonate and Santa Ana Electric Light Systems and the Santa Ana Public Market.

He died at Santa Clara, Cal., on February 3d, 1908, and was buried in Cypress Lawn Cemetery in the County of Santa Clara.

Mr. Scherzer was elected a Member of the American Society of Civil Engineers on January 6th, 1886.

CHARLES WIDNEY WOOD, M. Am. Soc. C. E.*

Died April 3d, 1911.

Charles Widney Wood was born in Pittsburg, Pa., on November 4th, 1863. He was the son of Captain B. D. Wood and Miriam A. (Widney) Wood. In 1866 his parents moved to New Orleans, La.

Mr. Wood was graduated from the Louisiana State University, after which he attended Rensselaer Polytechnic Institute at Troy, N. Y., from which he was graduated in 1884 with the degree of Civil Engineer.

From 1884 to 1888 Mr. Wood served in several capacities, including that of Assistant Engineer, for the Birmingham, Ala., Bridge and Bolt Works, but his health failing he was forced to resign and go to Colorado, where he remained for about a year.

On his return to New Orleans, he entered the firm of B. D. Wood and Sons. About this time he also engaged in the wreckage and salvage business, to which he devoted most of his time and in which he became highly expert. Among his notable accomplishments in this line of work was the salving of the Schooner *J. Frank Seavy,* which had been driven some seven miles inland on the marshes of Louisiana by the hurricane of 1893. Mr. Wood contracted to deliver this schooner afloat in the Gulf of Mexico. To do this he excavated a canal, five miles long, through which he floated the schooner intact into the Gulf. He was successful in raising many sunken steamboats and other vessels in the Mississippi River and its tributaries, including the U. S. S. *Wynoka* which had sunk near the mouth of Red River, in water of such depth that it was thought she could not be raised.

Mr. Wood was the originator of many special devices for use in his particular line of operations, and was the patentee of an apparatus which has been successfully used in extinguishing fires on shipboard. He was also the first to use an electro-magnet for lifting steel and iron from beneath the water, having utilized this device to rescue a cargo of nails and wire which had sunk in deep water in front of New Orleans.

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* Memoir prepared by J. F. Coleman, M. Am. Soc. C. E.

In 1886, Mr. Wood was married to Miss Ida Pettiss who, with five children, survives him. He also leaves two brothers and one sister.

Although Mr. Wood was a man of the most quiet habits, amounting almost to reserve, he had a subtle magnetism which drew other men to him in the warmest of friendships. He will long be remembered with affectionate regard by a large number of loyal friends.

Mr. Wood was elected a Member of the American Society of Civil Engineers on October 7th, 1908. He was also a Past-President of the Louisiana Engineering Society.

William P. Morse

PROCEEDINGS

OF THE

AMERICAN SOCIETY

OF

CIVIL ENGINEERS

VOL. XXXVII—No. 7

PRESENTED TO
N.J. CIVIL
ENGINEERING SOCIETY
BY
WILLIAM P. MORSE

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FOUNDED 1852

September, 1911

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(INSTITUTED 1852)

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◆

The House of the Society is open from 9 A. M. to 10 P. M. every day, except Sundays, Fourth of July, Thanksgiving Day, and Christmas Day.

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AMERICAN SOCIETY OF CIVIL ENGINEERS

INSTITUTED 1852

PROCEEDINGS

This Society is not responsible for any statement made or opinion expressed in its publications.

SOCIETY AFFAIRS

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MINUTES OF MEETINGS

OF THE SOCIETY

FORTY-THIRD ANNUAL CONVENTION, HELD IN CHATTANOOGA, TENN., JUNE 13TH-16TH, 1911.

FIRST SESSION*

Tuesday, June 13th, 1911.—The meeting was called to order at 10.25 A. M.; President Mordecai T. Endicott in the chair; Chas. Warren Hunt, Secretary; and present, also, about 125 members and guests.

The President introduced the Honorable T. C. Thompson, Mayor of Chattanooga, who welcomed the members to the city.

At the conclusion of Mr. Thompson's remarks, the President delivered the Annual Address.†

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* For the report in full of this and the Business Meeting, see page 415.

† The President's Address is printed in *Transactions*, Vol. LXXIII, page 392.

BUSINESS MEETING

Wednesday, June 14th, 1911.—Second Session.—The meeting was called to order at 10 A. M.; President Mordecai T. Endicott in the chair; Chas. Warren Hunt, Secretary; and present, also, about 75 members.

The Secretary presented a report giving the suggestions of members as to the Time and Place for holding the Annual Convention of 1912.*

On motion, duly seconded, the matter of the selection of the Time and Place for holding the next Annual Convention was referred to the Board of Direction, with power.

The Secretary read his report to the Board of Direction in reference to proposed changes in the method of issuing the publications of the Society.†

The Secretary read a communication from Emile Low, M. Am. Soc. C. E., in reference to changing the size of the publications of the Society.‡

On motion, duly seconded, the matter was referred to the Board of Direction.

Adjourned.

Wednesday, June 14th, 1911.—Third Session.—The meeting was called to order at 8.30 P. M.; President Mordecai T. Endicott in the chair; Chas. Warren Hunt, Secretary; and present, also, about 120 members and guests.

George F. Rowell, M. Am. Soc. C. E., described the Lock and Dam of the Chattanooga and Tennessee River Power Company at Hale's Bar, illustrating his remarks with lantern slides.

Adjourned.

September 6th, 1911.—The meeting was called to order at 8.30 P. M.; Vice-President Talbot in the chair; Chas. Warren Hunt, Secretary; and present, also, 113 members and 24 guests.

The minutes of the meetings of May 17th and June 7th, 1911, were approved as printed in *Proceedings* for August, 1911.

A paper by George B. Francis and Joseph H. O'Brien, Members, Am. Soc. C. E., entitled "The New York Tunnel Extension of the Pennsylvania Railroad: Certain Engineering Structures of the New York Terminal Area," was presented by Mr. O'Brien, who illustrated his remarks with lantern slides. A written communication on the subject by Charles B. Buerger, Assoc. M. Am. Soc. C. E., was presented by title by the Secretary.

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* See page 417.

† This report was printed in *Proceedings* for August, 1911, pages 319 to 321.

‡ See page 421.

The Secretary announced the election of the following candidates on September 5th, 1911:

As Members.

James Wadsworth Armstrong, New York City.
Albert Wells Buel, New York City.
Charles Adolphus Caldwell, Macon, Ga.
Halvor Olsen Hem, Kansas City, Mo.
Charles Hubbard Herrick, Boston, Mass.
Frank Hall Joyner, Los Angeles, Cal.
William Smelsor Moore, South Bend, Ind.
Ezra Booth Naylor, Nanking, China.
Francis Everett Pratt, Glen Ridge, N. J.
Elton Rice, Massillon, Ohio.
Paul Dudley Sargent, Washington, D. C.
Francis George Somner, Chico, Cal.
Charles Herbert Sweetser, Olympia, Wash.
Edmond Cornelis Van Diest, Colorado Springs, Colo.

As Associate Members.

David Morrice Brock, Memphis, Tenn.
Melvin David Casler, Mt. Vernon, N. Y.
John Halsey Cross, Quebec, Que., Canada.
George Alexander Miller Elliott, San Francisco, Cal.
Earl Jerome Ellison, Maywood, Ill.
Herman Henry Fox, Kansas City, Mo.
Douglas Basil Adair Graham, Chicago, Ill.
Lloyd Murray Grant, Seattle, Wash.
Wilson Gardner Harger, Rochester, N. Y.
Bruce Ritchie Honeyman, Portland, Ore.
Jean Georges Lefebvre Hopper, San Francisco, Cal.
Shaler Charles Houser, Guantanamo, Cuba.
Ged Hardy Justice, Hazard, Ky.
William Mather Lamson, New York City.
Daniel Handley McAllister, Provo City, Utah.
Oscar Alexander Mechlin, Washington, D. C.
Arthur Pomeroy Melton, Gary, Ind.
Charles Augustin Woodley Musson, Butte, Mont.
William Worth Pearse, New York City.
Charles Edwards Perry, Canajoharie, N. Y.
Cassius Morton Phinney, Sacramento, Cal.
Thomas Day Pierce, Cleveland, Ohio.
Frederick Hosea Richardson, Caldwell, Idaho.
Edward Marshall Rosher, Sagua la Grande, Cuba.
Edward Emmet Sands, Powell, Wyo.

Edward Frederick Sinz, Guantanamo, Cuba.
Frank Charles Starr, Washington, D. C.
Emory Sudler, Baltimore, Md.
Alfred von Siller, New York City.
James Joseph Walsh, San Francisco, Cal.
Ralph Mervine Warfield, Bremerton, Wash.
Alexander Ririe Young, Topeka, Kans.

As Associate.

James Dynan Newton, Chicago, Ill.

As Juniors.

Carl Mathias Duff, Boulder, Colo.
Stuart Chapin Godfrey, Washington, D. C.
John Adam Guissinger, Helena, Ark.
John Gibson Hendrie, Perth Amboy, N. J.
Clarence Edward Long, Pittsburg, Pa.
Leo Francis Murphy, Delray, Mich.
George Amos Payne, Clearing, Ill.
Harold Perrine, New York City.
Louis Powers, Elizabeth, N. J.
Robert Lawrence Rolfe, Memphis, Tenn.
Clarence Urling Smith, Spokane, Wash.
Nelson Taylor, Los Angeles, Cal.
Edgar Louis Thomssen, Toledo, Ohio.
Howard Sloan Thorne, Toledo, Ohio.
Wilmer Charles Van Duyne, East Orange, N. J.
William Cooper Walker, Syracuse, N. Y.

The Secretary announced the transfer of the following candidates on September 5th, 1911:

From Associate Member to Member.

Frederic Herbert Bass, Minneapolis, Minn.
John Potter Congdon, Pocatello, Idaho.
Mansfield Joseph French, Utica, N. Y.
George Albert Noska, New York City.
John Kimball Scammell, St. John, N. B., Canada.
Arthur Monroe Shaw, New Orleans, La.
Alfred Walton Stockett, Germiston, Transvaal, South Africa.
Granville Lewis Taylor, Wilkinsburg, Pa.
William Hammond Waugh, Manila, Philippine Islands.
Hans Hermann Wolff, Seattle, Wash.

FROM ASSOCIATE TO MEMBER.

THOMAS FRANK QUILTY, Chicago, Ill.

FROM ASSOCIATE TO ASSOCIATE MEMBER.

GEORGE MERRICK HERRON, Palo Alto, Cal.
EDWARD PERCIVAL THOMPSON, Manila, Philippine Islands.

FROM JUNIOR TO ASSOCIATE MEMBER.

GEORGE WILLIAM BURPEE, Merivale, Ont., Canada.
CLINTON HERVEY CROOKS, New York City.
CLARENCE SYLVESTER JARVIS, Provo, Utah.
JEREMIAH DANIELS RICHARDSON, Corona, N. Y.
CHARLES SCHULTZ, Muskogee, Okla.
MARION deKALB SMITH, JR., Chestertown, Md.
JOHN ROBERT WILBANKS, Little Rock, Ark.
CHARLES RAPELYEA WYCKOFF, Brooklyn, N. Y.

The Secretary announced the following deaths:

JAMES CHRISTIE, elected Member May 7th, 1873; died August 24th, 1911.

FRANCIS COLLINGWOOD, elected Member March 3d, 1869; died August 18th, 1911.

CHARLES ARTHUR HAGUE, elected Member February 3d, 1892; died June 25th, 1911.

EDWARD MARION KENLY, elected Member May 4th, 1904; died June 10th, 1911.

WALLACE McGRATH, elected Member September 5th, 1883; died December 5th, 1909.

EDWARD P. NORTH, elected Member December 4th, 1867; died July 20th, 1911.

HENRY PIERCE, elected Member December 5th, 1894; died August 21st, 1911.

ALFRED FRANCIS SEARS, elected Member June 2d, 1869; died June 7th, 1911.

WILLIAM DANA TAYLOR, elected Member March 1st, 1899; died August 26th, 1911.

JOSEPH CANBY HADSALL, elected Associate Member November 8th, 1909; died June 29th, 1911.

HOMER AUSTIN PATCH, elected Associate Member January 8th, 1908; died April 4th, 1911.

JOSEPH HECKART FRAZER, elected Junior March 31st, 1908; date of death unknown.

RICHARD HAZEN, elected Junior November 8th, 1909; died August 13th, 1911.

Adjourned.

OF THE BOARD OF DIRECTION

(Abstract)

September 5th, 1911.—Vice-President Boller in the chair; Chas. Warren Hunt, Secretary, and present, also, Messrs. Bates, Clarke, Kimball, Knap, Loomis, Loweth, Ridgway, Snow, Stuart, Talbot, and Thompson.

Upon a favorable report from the Publication Committee, the change, suggested some time ago by the Secretary, in the method of issuing *Transactions,* viz., to issue one volume per annum instead of four, during 1912, was adopted.

The Report of the Nominating Committee was received.

At the request of the Special Committee on Bituminous Materials for Road Construction, the Board authorized the holding of meetings for the discussion of Road Construction on the Friday and Saturday next succeeding the days of the Annual Meeting of 1912.

Ballots for membership were canvassed, resulting in the election of 14 Members, 32 Associate Members, 1 Associate, and 16 Juniors, and the transfer of 8 Juniors to the grade of Associate Member.

Ten Associate Members and one Associate were transferred to the grade of Member, and two Associates were transferred to the grade of Associate Member.

Applications were considered, and other routine business transacted.

Adjourned.

REPORT IN FULL OF THE FIRST SESSION OF THE FORTY-THIRD ANNUAL CONVENTION, AND OF THE BUSINESS MEETING, HELD IN THE ASSEMBLY HALL OF THE HOTEL PATTEN, CHATTANOOGA, TENN.

FIRST SESSION

Tuesday, June 13th, 1911.—The meeting was called to order at 10.25 A. M.; Mordecai T. Endicott, President, in the chair; Chas. Warren Hunt, Secretary; and present, also, about 75 members and many guests.

THE PRESIDENT.—Coming here to open the 43d Annual Convention of the American Society of Civil Engineers, is His Honor, the Mayor of the City, who is here to welcome you to Chattanooga. I beg to introduce the Honorable T. C. Thompson.

Address o welcome.

HON. T. C. THOMPSON.—Mr. President, Ladies and Gentlemen, in the latter part of 1864, when Bragg began his retreat from Missionary Ridge to Dalton, he gave orders that there should be no stragglers, as his army was then very few in numbers. Among others, a minister of the gospel was sent out to keep up the stragglers. Just at the edge of Missionary Ridge, on the way to Chickamauga Park, this parson, who was pretty well fed, splendidly dressed, and pretty well mounted, met a soldier and said to him: "You are not obeying orders. The orders are that straggling shall not be permitted in this army on this retreat. What command do you belong to?" The soldier replied, "I belong to Hood's Texas Rangers." The chaplain retorted: "Your headquarters are four miles to the front; you must hurry on and keep up." The soldier said: "They have kept me fighting all day and marching all night. I am doing the best I can. I will catch up with headquarters after a while." The parson started to ride off, and the soldier called to him: "Captain, what army do you belong to?" He drew himself up proudly, and said: "I belong to the Army of the Lord." The private answered: "Well, you are a ——— sight farther from your headquarters than I am from mine."

It is true, Mr. President, that I would be just a little bit away from headquarters, in addressing the American Society of Civil Engineers, except for this fact: I sat at the feet of a man who was a chief of artillery in the late unpleasantness, and a graduate of West Point. He was a distinguished civil engineer, and after the war he naturally returned to his chosen profession. So, with this little experience, I might not be so very far from headquarters after all.

I have the honor of extending to you the hospitality of this busy and cosmopolitan community, for which I speak to-day and from which I bring you welcome. Probably no city in America to-day

Address of welcome (continued).

more truly typifies the American spirit than this city. Down here we do not know any North, any South, any East, or any West. I am the son of an American soldier, and I am proud of it, but I defy any one of you to tell whether he fought in the blue or in the gray uniform. I am an American myself. That is what we particularly stand for—Americanism.

When you go down to Chickamauga Park, please bear these facts in mind. I do not wish to bore you with dry figures, but perhaps the greatest battle of the late war was fought with that beautiful setting, where 59 000 men were opposed to 40 000 others in a death grapple. When they separated one army held the field and the other held Chattanooga. Neither side won and neither side lost. Out of the 99 000 engaged, 38 000 were left on that field. Even Gettysburg cannot show such figures. The Confederates fought well at Chickamauga, but they lost. Had they won, it would have changed American history, as well as that of Chattanooga. The backbone of the Confederacy was broken in that engagement, resulting in the retaining of the Union.

Just another remark before I close: Kentucky has erected a monument to its soldiers, on both sides, who fought and died there. The people of Chattanooga would like you to see the inscription on that monument. It reads something like this:

> "As we are united in life and they united in death, let one monument perpetuate their deeds, and one people, forgetful of all asperities, forever hold in grateful remembrance all the glories of that terrible conflict, which made all men free and retained every star on the Nation's flag."

Now, ladies and gentlemen, it is in that spirit that Chattanooga bids you men from all over this great nation welcome to our city, and says to you: "Whatever is ours is yours." (Applause.)

Reply to address of welcome.

THE PRESIDENT.—Your Honor, we thank you very much for this pleasant and gracious welcome to your city. It is not the first time that the American Society of Civil Engineers has visited you. Yesterday morning, as I was passing through the prosperous, beautiful country of Southwest Virginia and the eastern part of this State, with its towering mountains, fertile valleys, and beautiful plains, it seemed to me that it was, and it is, an ideal approach to your pleasant, beautiful, and delightful city. We can take away with us many memories of things which have charmed us and attracted our interest; and, I think I can say, more than anything else, that which every Southern city has—gallant and chivalrous men and beautiful and attractive women. I am sure that our sojourn here will be pleasant and will equal our anticipations. (Applause.)

(The President then delivered the Annual Address.*)

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* *Transactions*, Am. Soc. C. E., Vol. LXXIII, p. 392.

Changes i Pro-gramme.

THE SECRETARY.—Mr. President, the programme of the Convention was sent out to the members of the Society some time ago, and copies have been distributed; but there have been some changes, and, as the work was done by a local committee and the chairman of that committee is present, we should like to hear from him now as to the changes which have been made.

(William Dunbar Jenkins, M. Am. Soc. C. E., Chairman of the Local Committee, then announced the principal features of the programme, as finally arranged.)

THE PRESIDENT.—Mr. Secretary, are there any more announcements?

THE SECRETARY.—No, Mr. President, I do not know of anything else, sir.

THE PRESIDENT.—The meeting will stand adjourned.

BUSINESS MEETING

Business Meeting called to order.

Wednesday, June 14th, 1911.—The meeting was called to order at 10 A. M.; Mordecai T. Endicott, President, in the chair; Chas. Warren Hunt, Secretary, and present, also, about 75 members.

THE SECRETARY.—The only business to come before this meeting is the consideration of the time and place for holding the next Annual Convention. I have a report on that subject which I will read.

Report of the Secretary on Suggestions Received as to the Time and Place for Holding the Annual Convention of 1912.

Conventio of 1912.

"On May 12th, 1911, a circular was sent to the entire membership of the Society in order that each member might express his particular preference as to the place for holding the next Annual Convention, and as to the time most suitable for holding it.

"In response to this circular 354 suggestions have been received, which may be summarized as follows:

Baltimore, Md.	33	Pittsburg, Pa.	11
Seattle, Wash.	18	Saratoga, N. Y.	9
Atlantic City, N. J.	17	Chicago, Ill.	8
Detroit, Mich.	17	Minneapolis, Minn.	8
Boston, Mass.	16	Mackinac Island, Mich.	7
New Orleans, La.	16	Niagara Falls, N. Y.	6
New York City	13	Kansas City, Mo.	6
Los Angeles, Cal.	13	Salt Lake City, Utah	6
San Francisco, Cal.	13	Sault Ste. Marie, Mich.	6
Portland, Ore.	12	Buffalo, N. Y.	5
Denver, Colo.	11	Rochester, N. Y.	5
Duluth, Minn.	11	Washington, D. C.	5

Convention of 1912 (continued).

Ottawa, Ont., Canada	4	Cooperstown, N. Y.	2
Louisville, Ky.	4	Atlanta, Ga.	2
Quebec, Que., Canada	4	Kineo, Me.	2
Steamer on Great Lakes	3	Montreal, Que., Canada	2
Milwaukee, Wis.	3	Norfolk, Va.	2
Panama	3	Portland, Me.	2
Philadelphia, Pa.	3	Providence, R. I.	2
St. Louis, Mo.	3	Watch Hill, R. I.	2

"The following have received one vote each:

Adirondacks.
Albany, N. Y.
Birmingham, Ala.
Boise, Idaho.
Canal Zone, Panama.
Cape May, N. J.
Colorado Springs, Colo.
Dallas, Tex.
Galveston, Tex.
Great Falls, Mont.
Harrisburg, Pa.
Havana, Cuba.
Helena, Mont.
Hot Springs, Va.
Houston, Tex.
Lexington, Ky.
Memphis, Tenn.
Mobile, Ala.
Near Great Lakes.
Oklahoma, City, Okla.
Old Point Comfort, Va.
Orange, N. J.
Paris, France.
Phœnix, Ariz.
Pittsfield, Mass.
Richmond, Va.
Roanoke, Va.
Savannah, Ga.
Spokane, Wash.
St. Paul, Minn.
Tampa, Fla.
Thousand Islands, N. Y.
Toledo, Ohio.
Yellowstone National Park.
Winnipeg, Man., Canada.
Yosemite Valley, Cal.
On board a steamer sailing from New Orleans to Colon and return.
Some Western City.
Twin Cities, St. Paul and Minneapolis.

"As to the time for holding the Convention, there is a great variety of opinion:

January has received	1	vote.	October	8	votes.
February	4	votes.	March or April	1	vote.
March	4	"	April or May	2	votes.
April	3	"	May or June	2	"
May	29	"	May or September	1	vote.
June	188	"	June or July	9	votes.
July	40	"	June or September	1	vote.
August	4	"	June or October	1	"
September	11	"	July or August	2	votes.

September or October...	1 vote.
December or January..	1 “
Any time between June 1st and September 30th.	2 votes.
Early Spring	1 vote.
Spring	1 “
Easter Vacation........	1 “
Fall	1 “
Late Fall..............	1 “
Late Fall or Winter.....	1 vote.
Just before or after the time of the XIIth International Congress of Navigation	1 “
In cool weather.........	1 “
In the “good old summer time”	1 “

“Respectfully submitted,

“Chas. Warren Hunt,
“Secretary.”

Mr. President, I have some letters advocating the holding of the Convention at different places. One is from a member residing in Cooperstown, and there is also an invitation from the Engineers' Club, of Baltimore, which is as follows:

“Engineers' Club of Baltimore,
“Baltimore, Md., May 19th, 1911.

“Mr. Charles Warren Hunt,
“Secretary, American Society Civil Engineers,
“220 W. 57th Street, New York City.

“Dear Sir: The Engineers' Club, of Baltimore, at its meeting on April 27th, 1911, unanimously passed a resolution respectfully inviting the American Society of Civil Engineers to hold its annual convention for the year 1913 in the City of Baltimore, and I have the honor herewith to submit this invitation.

“The Club, in extending this invitation, has the indorsement of the Mayor and City Council, the Board of Trade, and other similar organizations of the City; and at the proper time full information as to entertainment, hotel accommodations, etc., will be supplied by the Publicity Bureau.

“In the City and its suburbs there is being spent fifty million dollars ($50,000,000) in constructing the most comprehensive sewerage system, a most comprehensive municipal system of docks, a twenty billion gallon impounding reservoir and filter plant, a high-pressure fire system, the only ozone water-sterilizing plant in the country, a most comprehensive system of parks and boulevards, and many miles of improved street paving, etc., etc.

“The Club will send official delegates to the coming convention of the Society in Chattanooga who will be delighted to supply you with any information you may wish, or you may obtain any additional data directly from me.

“Very respectfully,
“Jas. W. Sinkly,
“President.”

Convention of 1912 (continued).

THE PRESIDENT.—You have heard the suggestions that have been made as to the various places and various dates. What is the pleasure of the meeting? Shall we decide that at this time, or refer the matter to the Board of Direction, as has been done in many instances in the past?

(On motion, duly seconded, it was ordered that the matter of the time and place for the next Annual Convention be referred to the Board of Direction, with power.)

Change in Method of Publishing *Transactions.*

THE SECRETARY.—Mr. President, a matter which is of general interest to the members of the Society is a proposed change in the method of publishing the *Transactions*. I have submitted a report to the Board of Direction, and the subject is now under consideration.

(The Secretary read his report on the proposed change in the method of Society Publications.*)

THE SECRETARY.—I feel that I should state to the Meeting the purposes of this proposed change. We will have the same amount of material, and probably more discussions. In place of four separate volumes with four separate indexes, occupying quite a large space, there will be one volume, the thickness of which will be a little less than half the aggregate of the four. The fact that we would only have to get out one volume a year would enable us to prolong the discussions for several months, if necessary, whereas the present system frequently shuts them out. For instance, I received a very interesting discussion from a member in the Philippines, and he had evidently written it as soon as he got the paper, but, owing to the fact that the volume had gone to press, his discussion was shut out.

A MEMBER.—Does the recommendation of the Secretary include a reduction or change in the size of the volume?

THE SECRETARY.—Yes, sir.

A MEMBER.—Will the *Proceedings* and the discussions be bound together, or will they be separated as now, that is, will the volume contain the *Proceedings* of the Society and also the discussions?

THE SECRETARY.—The *Proceedings* as now issued consist of two parts, one part contains Society Affairs and one contains the papers in advance of the time they are to be presented to the Society for discussion. This part also contains discussions of papers which have been presented. That method will be continued. The effect of the proposed change, in my opinion, will be to stimulate cross-discussion and produce more than is possible under the present system. Each paper is published in the *Proceedings* some six weeks, perhaps, before it is presented to the Society. It comes up at a stated meeting, and all the discussions we can get are printed in the next number of *Proceedings;* then we have to wait thirty days longer before the discussion can be closed. If the discussion was continued for another month, it would mean that the paper would have to be held open three months, but with only one volume of *Transactions* a year, it would not be necessary to close the discussion so soon. There is another feature of the proposed change: Members would not have to wait for separate copies of a paper until the volume is published, for copies would be available just as soon as the discussion is closed, as the paper would go through the press perhaps six months or more before the volume was issued.

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* Printed in the *Proceedings* for August, 1911, p. 319.

Proposed change in size of *Proceedings* and *Transactions.*

I have a letter from a Member addressed to the members of this Society in Annual Convention assembled, which I presume should be read.

"606 Ashland Avenue,
"BUFFALO, N. Y., June 10, 1911.

"To the Members of the
"American Society of Civil Engineers,
"Annual Convention, 1911,
"Chattanooga, Tenn.

"GENTLEMEN: At the present time there is a marked tendency toward standardization and uniformity in all branches of business.

"The vertical system of filing has revolutionized the method of filing letters, documents, catalogs, and kindred matter, certainly an improvement over the old method of folding and filing in boxes, with its inherent defects not necessary to mention here.

"With the introduction of the vertical filing system, the old-time sizes of publications are also being changed so as to correspond with the ordinary size of letter heads, which is 8 x 10½ inches.

"In view of these facts I would respectfully suggest that the size of the *Proceedings* and *Transactions* of the Society be changed to 8 x 10½ inches.

"Some letters bearing on this subject accompany this communication.

"Very respectfully,
"EMILE LOW,
"M. Am. Soc. C. E."

(On motion, duly seconded, it was ordered: That this subject be referred to the Board of Direction.)

Announcements.

THE PRESIDENT.—Major Jenkins, of the local committee, has some announcements to make.

MAJOR JENKINS.—Members of the Society, I am pleased to state that a party is being made up to visit Lookout Mountain this afternoon. As I see no ladies present, I know all who came with ladies will give them this information. The trip will be made on the regular cars and incline. The cars can be taken at Ninth and Market Streets, about a block and a half up the street. They are all marked "Lookout Mountain." The ladies of the local committee will serve a basket picnic lunch, and the party will return to the hotel at about 7.00 P. M. The members and guests are invited.

Announcements (continued).

A MEMBER.—At what time?

MAJOR JENKINS.—The cars will leave at 3 P. M.

THE SECRETARY.—Are those special cars, Major?

MAJOR JENKINS.—I suppose that special cars will be arranged for the accommodation of the party at that time, but if any one should miss the special cars he can get out to the incline on the regular cars and take the incline cars to the top. I wish to call attention to the fact that on Friday, June 16th, at 11 o'clock, we are to take the cars—special coaches—about a block from the hotel, at the T. A. G. Station, and go to the water-works. Those who take this trip will be much interested. They will be entertained by Mr. Bixby, the General Manager. A luncheon will be served after the plant has been inspected. I suppose the trip will consume about two hours; but, as a golf tournament is to be held at the Golf and Country Club that afternoon, we would like the members to return from the water-works as soon as possible. They can return and take the street cars to the Golf and Country Club as soon as they arrive at the station in Chattanooga. This tournament will be given on Friday afternoon, June 16th, and the local committee has offered five prizes, two for gentlemen, consisting of first and second prize, for the best medal score, also prizes for the ladies, if any take part in the tournament, and there is one prize for the longest drive. These events will be open to all members and guests, and we request that all golfers among the engineers will register their names with the Secretary's assistant in the writing-room at the hotel. Even if they are not expert, they should all go out to the tournament, as they will enjoy it, I am sure. It is hoped that there will be a large attendance, as the privileges of the club have been extended to the Society and friends, and to all the ladies.

As stated yesterday, there will be an excursion to the Lock and Dam to-morrow, leaving the Union Station at 9.30 A. M. We will go by rail, as the stage of the water in the river does not permit of navigation.

THE SECRETARY.—I would like to ask if this train is going to move promptly at 9.30? The difficulty of getting the members to the Business Meeting causes me to feel that it might be equally hard to get them to the train.

JAMES A. FAIRLEIGH, M. AM. SOC. C. E.—I can state positively that the train will move promptly at 9.30 A. M.

MAJOR JENKINS.—The members might start at 9.15, so as to be in time for the 9.30 train.

MR. FAIRLEIGH.—The train leaves from the Union Depot, and not the Terminal.

MAJOR JENKINS.—Yes, opposite the Read House, on Ninth Street.

THE SECRETARY.—At 8.30 P. M., in this hall, there will be an address with lantern-slide views of the Lock and Dam by George F. Rowell, M. Am. Soc. C. E., and I think it will be desirable for all members to hear this description, and thus secure advance information as to what is going on at the Lock and Dam, and thus prepare themselves to enjoy more fully the interesting work that they are to see to-morrow.

Mr. Fairleigh.—I would like to add a few details about the trip to the Mountain this afternoon. The trip was conceived, and is being executed primarily, for the benefit of the ladies of the party, by the ladies of the local committee. Therefore, I hope that all the ladies who are here will avail themselves of this opportunity. The local ladies will prepare lunches—a basket picnic, I believe they call it—and it will be served at the New York Monument. All that is necessary is to walk toward the Point and you will soon come to the New York Monument.

A Member.—Point of the park?

Mr. Fairleigh.—The Point Park, where the New York Monument is located; directly north from the Incline station. The cost of the trip will be paid by the persons who go; it will be approximately 60 cents; 10 cents on the railroad and 50 cents on the incline at the Mountain. I want to impress on the members that the ladies will be disappointed—the committee will be disappointed—if all the ladies do not attend, and I trust that as many members as possible will go along.

A Member.—Is that a special rate on the Incline Railway?

Mr. Fairleigh.—The rate, as I understand it, will be 50 cents for the round trip. The luncheon will be served at about six o'clock, after the party has had a chance to walk around and view the scenery; after that the return will be made to the hotel in time for the address on the Lock and Dam by Mr. Rowell.

I think that Lookout Mountain is one of the important points of interest around Chattanooga, and that every member who has not been there should certainly make an effort to go. If you leave Chattanooga without seeing it, you will have missed one of the prettiest views of this city, and I simply want to urge on all to attend if possible.

The Secretary.—Mr. President, I have been requested by the Secretary of the Nominating Committee to state that that committee will meet this evening in this house at eight o'clock. A room will be provided, and the members of the committee will make inquiry at the desk and be told where the room is located.

Mr. Fairleigh.—I neglected to state that we will leave the hotel at 3.30 o'clock this afternoon.

The Secretary.—I think we had better fix that time. If we want to catch the cars at 3.30, we must leave the hotel at 3.15.

Major Jenkins.—I understand, then, Mr. Fairleigh, it is definitely

Announcements (continued).

fixed that the cars will be at Ninth and Market Streets. You can get on either of two lines, the Alton Park line or to go to Ninth and Market Streets and take the Lookout Mountain car. The Alton Park line passes right in front of the hotel here. Either line goes directly to the incline.

You will find that information written out at the desk of the Secretary's assistant. You will remember that the basket picnic will begin at six o'clock.

THE PRESIDENT.—Has any member any business to put before this meeting?

THE SECRETARY.—Will you announce, Mr. President, the meeting of the Board of Direction?

THE PRESIDENT.—There will be a meeting of the Board of Direction immediately after the adjournment of this meeting, and I will ask the members of the Board to meet at once.

(There being no further business to be brought before the Society the meeting was adjourned.)

FORTY-THIRD ANNUAL CONVENTION

EXCURSIONS AND ENTERTAINMENTS

The arrangements for the Convention were in the hands of the following Committees:

Committee of Arrangements of the Board of Direction

HUNTER McDONALD, *Chairman;*
WILLIAM E. BELKNAP, CHAS. WARREN HUNT.

Local Committee

WILLIAM DUNBAR JENKINS, *Chairman;*
E. E. BETTS,
H. S. BOSLER,
W. H. CONVERSE,
J. A. FAIRLEIGH,
C. H. FISK,
D. H. WOOD,
W. W. HARTS,
W. W. CARSON,
W. M. GARDNER,
W. H. COURTENAY,
J. W. KENDRICK,
J. N. HAZLEHURST,
T. G. DABNEY,
W. S. LEE,
J. E. SIRRINE,
GEORGE E. ROWELL,
W. F. REICHARDT.

Informal Reception

Monday, June 12th, 1911.—During the evening an informal reception was held at the Hotel Patten, which was largely attended by members and guests.

Excursion to Fort Oglethorpe

Tuesday, June 13th, 1911.—There was an excursion to Fort Oglethorpe by trolley; thence, by tally-ho coaches and stages, the party was driven through Chickamauga Battle Fields Park, and, *via* the Crest Road on Missionary Ridge, back to Chattanooga.

Picnic on Lookout Mountain

Wednesday, June 14th, 1911.—By invitation of the ladies of the Local Committee the entire party was invited to a basket picnic on Lookout Mountain. This was a delightful affair, and was very largely attended.

Excursion to Hale's Bar

Thursday, June 15th, 1911.—Owing to low water in the Tennessee River, it was not possible to go down the river by steamer, as originally intended, and the party was therefore taken by special train, by courtesy of the Louisiana, Chattanooga and St. Louis Railway, to Hale's Bar, where the hydro-electric development construction works of the Chattanooga and Tennessee River Power Company were inspected. Through the courtesy of Messrs. Jacobs and Davies, Inc., Constructing and Consulting Engineers on this work, the large party was entertained at luncheon, and the return to Chattanooga was made by special train over the L., C. & St. L. Ry., which was stopped *en route* to examine specially interesting points of railroad construction, notably the elimination of the Summit Tunnel, which is now in progress.

In the evening there was a well attended and enjoyable Reception with dancing at the Hotel Patten.

Excursion to the Chattanooga Water-Works, etc.

Friday, June 16th, 1911.—A special excursion to the water-works plant, L. H. Bixby, General Manager, and to other works of interest was made, and in the afternoon the entire party met at the Chattanooga Golf and Country Club where, by courtesy of the Club, a number of members and guests enjoyed a golf tournament for which four prizes had been furnished by the Local Committee.

During the entire Convention, facilities for visits to the many interesting historical and scenic points about Chattanooga, as well as to many of the industrial and manufacturing plants, were furnished by the Local Committee.

Attendance

The following 87 Members were in attendance. There were also present 124 ladies and others of the families of members.

Aiken, W. A...Philadelphia, Pa.
Alsberg, Julius..New York City
Andrews, D. M.......Rome, Ga.
Auryansen, F....Jamaica, N. Y.
Ayres, W. E.....Memphis, Tenn.

Baldwin, A. S......Chicago, Ill.
Bates, Onward .....Chicago, Ill.
Belknap, W. E...New York City
Bensel, J. A.......Albany, N. Y.
Betts, E. E..Chattanooga, Tenn.
Bogart, John....New York City
Bosler, H. S., Chattanooga, Tenn.
Bright, C. E......Riverton, Ala.

Carson, W. W..Knoxville, Tenn.
Clarke, G. C...New York City
Class, C. F.......Camden, N. J.
Coleman, J. F..New Orleans, La.
Connor, E. H., Leavenworth, Kans.
Connor, W. D., Washington, D. C.
Converse, W. H., Chattanooga, Tenn.
Cotton, J. P.....Newport, R. I.
Coulson, Ben L..Sewanee, Tenn.
Courtenay, W. H., Louisville, Ky.

Dabney, A. L..Clarksdale, Miss.
De Berard, W. W...Chicago, Ill.

Endicott, M. T., Washington, D. C.

Fain, J. R.....Harriman, Tenn.
Fairleigh, J. A., Chattanooga, Tenn.

Fay, F. H.........Boston, Mass.
Forgie, James..New York City
Fuqua, P. D.........Rome, Ga.

Giddings, Frederick, Atchison, Kans.
Greiner, J. E....Baltimore, Md.

Hansen, Paul, Bowling Green, Ky.
Harlow, J. H...Darlington, Md.
Harts, W. W...Nashville, Tenn.
Haugh, J. C...New Orleans, La.
Hazlehurst, J. N...Atlanta, Ga.
Hovey, O. E....New York City
Howard, E. E..Kansas City, Mo.
Howe, H. N....Memphis, Tenn.
Howie, H. B. W., Chattanooga, Tenn.
Hunt, Chas. Warren, New York City

Jenkins, W. D., Chattanooga, Tenn.
Johnson, T. H....Pittsburg, Pa.
Jones, H. M....Nashville, Tenn.
Juengst, H. F....Pittsburg, Pa.

Kellogg, N. B., San Francisco, Cal.
King, P. S....Philadelphia, Pa.
Kinney, W. M....Pittsburg, Pa.

Leffler, B. R....Cleveland, Ohio
Lewis, E. C....Nashville, Tenn.
Lewis, F. H..Birmingham, Ala.
Lindsey, Kieffer......Rome, Ga.
Little, G. K....Tuscaloosa, Ala.
Lyerly, C. A., Jr., Chattanooga, Tenn.
Lynch, M. L.....Jackson, Miss.

McDonald, Hunter, Nashville, Tenn.
McLure, N. R....St. Louis, Mo.
Meem, J. C.....Brooklyn, N. Y.
Miller, C. H.....St. Louis, Mo.
Mitcham, G. N....Auburn, Ala.
Montfort, Richard, Louisville, Ky.
Moorshead, T. C......Alton, Ill.

Norcross, P. H.....Atlanta, Ga.

Olney, A. C..Birmingham, Ala.

Patton, W. B.....Duluth, Minn.
Pew, Arthur.......Atlanta, Ga.
Pickett, W. D....Lexington, Ky.

Ridgway, Robert, Poughkeepsie, N. Y.
Rowell, G. F......Guild, Tenn.

Schneider, C. C., Philadelphia, Pa.
Schulz, W. F....Memphis, Tenn.
Solomon, G. R.....Atlanta, Ga.
Spencer, Herbert..New York City

Thomas, R. D., Minneapolis, Minn.
Tilden, C. J...Ann Arbor, Mich.
Todd, A. M.....Vicksburg, Miss.

Van Cleve, A. H., New York City

Wall, Edward E..St. Louis, Mo.
Warner, J. E.......Benton, Mo.
West, C. H.....Greenville, Miss.
Wingfield, Nisbet..Augusta, Ga.
Wood, D. H..Chattanooga, Tenn.
Worcester, J. R...Boston, Mass.

Yappen, A.........Chicago, Ill.
Young, O. E......Lincoln, Ala.

ANNOUNCEMENTS

The House of the Society is open from 9 A. M. to 10 P. M., every day, except Sundays, Fourth of July, Thanksgiving Day, and Christmas Day.

FUTURE MEETINGS

October 4th, 1911.—8.30 P. M.—This will be a regular business meeting. A paper by Wilson Sherman Kinnear, M. Am. Soc. C. E., entitled "The Detroit River Tunnel," will be presented for discussion.

This paper was printed in *Proceedings* for August, 1911.

October 18th, 1911.—8.30 P. M.—At this meeting a paper by George Gibbs, M. Am. Soc. C. E., entitled "The New York Tunnel Extension of the Pennsylvania Railroad: Station Construction, Road, Track, Yard Equipment, Electric Traction, and Locomotives," will be presented for discussion.

This paper was printed in *Proceedings* for May, 1911.

November 1st, 1911.—8.30 P. M.—A regular business meeting will be held and two papers will be presented for discussion, as follows: "Some of the Properties of Oil-Mixed Portland Cement Mortar," by Logan Waller Page, M. Am. Soc. C. E., and "Reinforced Concrete Bridge Across the Almendares River, Havana, Cuba," by Eugene Klapp and W. J. Douglas, Members, Am. Soc. C. E.

These papers are printed in this number of *Proceedings*.

November 15th, 1911.—8.30 P. M.—A paper by W. W. Clifford, Jun. Am. Soc. C. E., entitled "A Reinforced Concrete Stand-Pipe," will be presented for discussion.

This paper is printed in this number of *Proceedings*.

SEARCHES IN THE LIBRARY

In January, 1902, the Secretary was authorized to make searches in the Library, upon request, and to charge therefor the actual cost to the Society for the extra work required. Since that time many searches have been made, and bibliographies and other information on special subjects furnished.

The resulting satisfaction, to the members, who have made use of the resources of the Society in this manner, has been expressed frequently, and leaves little doubt that, if it were generally known to the membership that such work would be undertaken, many would avail themselves of it.

The cost is trifling compared with the value of the time of an engineer who looks up such matters himself, and the work can be performed quite as well, and much more quickly, by persons familiar with the Library.

In asking that such work be undertaken, members should specify clearly the subject to be covered, and whether references to general books only are desired, or whether a complete bibliography, involving search through periodical literature, is desired.

In reference to this work, the Appendices* to the Annual Reports of the Board of Direction for the years ending December 31st, 1906, and December 31st, 1910, contain summaries of all searches made to date.

PAPERS AND DISCUSSIONS

Members and others who take part in the oral discussions of the papers presented are urged to revise their remarks promptly. Written communications from those who cannot attend the meetings should be sent in at the earliest possible date after the issue of a paper in *Proceedings.*

All papers accepted by the Publication Committee are classified by the Committee with respect to their availability for discussion at meetings.

Papers which, from their general nature, appear to be of a character suitable for oral discussion, will be published as heretofore in *Proceedings,* and set down for presentation to a future meeting of the Society, and, on these, oral discussions, as well as written communications, will be solicited.

All papers which do not come under this heading, that is to say, those which, from their mathematical or technical nature, in the opinion of the Committee, are not adapted to oral discussion, will not be scheduled for presentation to any meeting. Such papers will be published in *Proceedings* in the same manner as those which are to be presented at meetings, but written discussions, only, will be requested for subsequent publication in *Proceedings* and with the paper in the volumes of *Transactions.*

LOCAL ASSOCIATIONS OF MEMBERS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS

San Francisco Association

The San Francisco Association of Members of the American Society of Civil Engineers holds regular bi-monthly meetings, with banquet, and weekly informal luncheons. The former are held at 6 P. M., at the Palace Hotel, on the third Friday of February, April, June, August, October, and December, the last being the Annual Meeting of the Association.

Informal luncheons are held at 12.15 P. M. every Wednesday, and the place of meeting may be ascertained by communicating with the Secretary of the Association, E. T. Thurston, Jr., M. Am. Soc. C. E., 713 Mechanics' Institute, 57 Post Street.

The by-laws of the Association provide for the extension of hospitality to any member of the Society who may be temporarily in San Francisco, and any such member will be gladly welcomed as a guest of the Association at any of the above meetings, if he will notify the Secretary that he is in San Francisco.

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*Proceedings, Vol. XXXIII, p. 20 (January, 1907); Vol. XXXVII, p. 28 (January, 1911).

(Abstract of Minutes of Meeting)

June 16th, 1911.—The meeting was called to order; President Derleth in the chair; E. T. Thurston, Jr., Secretary; and present, also, 54 members and guests.

President Derleth reported that the committee of three appointed to consider the question of securing engineering representation in connection with the Panama-Pacific Exposition, had communicated with the American Society of Civil Engineers and had received a reply from Chas. Warren Hunt, Secretary, stating that the question had been referred to a special committee of three, to be appointed by the President of the Society, with instructions to report back to the Board of Direction as soon as possible. President Derleth also made a brief report in regard to the work of the Committees in connection with the selection of a site for the Exposition.

Announcements were made by Messrs. Wagoner and Derleth relative to the proposed amalgamation of the local engineering societies.

A paper giving a detailed description of the engineering features in connection with the design of the South San Joaquin Irrigation System, was read by Edwin Duryea, Jr., M. Am. Soc. C. E., who illustrated his remarks with stereopticon views, and the subject was discussed by the members present.

Adjourned.

Colorado Association

The meetings of the Colorado Association of Members of the American Society of Civil Engineers are held on the second Saturday of each month, except July and August. The hour and place of meeting are not fixed, but this information will be furnished on application to the Secretary, Gavin N. Houston, M. Am. Soc. C. E., 409 Equitable Building, Denver, Colo. The meetings are usually preceded by an informal dinner. Members of the American Society of Civil Engineers will be welcomed at these meetings.

Weekly luncheons are held on Wednesdays, and until further notice, will take place at The Colorado Traffic Club.

Visiting members are urged to attend the meetings and luncheons.

PRIVILEGES OF ENGINEERING SOCIETIES EXTENDED TO MEMBERS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS

Members of the American Society of Civil Engineers will be welcomed by the following Engineering Societies, both to the use of their Reading Rooms and at all Meetings:

American Institute of Mining Engineers, 29 West Thirty-ninth Street, New York City.

Architekten-Verein zu Berlin, Wilhelmstrasse 92, Berlin W. 66, Germany.

Associação dos Engenheiros Civis Portuguezes, Lisbon, Portugal.

Australasian Institute of Mining Engineers, Melbourne, Victoria, Australia.

Boston Society of Civil Engineers, 715 Tremont Temple, Boston, Mass.

Brooklyn Engineers' Club, 117 Remsen Street, Brooklyn, N. Y.

Canadian Society of Civil Engineers, 413 Dorchester Street, West, Montreal, Que., Canada.

Civil Engineers' Society of St. Paul, St. Paul, Minn.

Cleveland Engineering Society, Chamber of Commerce Building, Cleveland, Ohio.

Cleveland Institute of Engineers, Middlesbrough, England.

Dansk Ingeniorforening, Amaliegade 38, Copenhagen, Denmark.

Engineers' and Architects' Club of Louisville, Ky., 303 Norton Building, Fourth and Jefferson Streets, Louisville, Ky.

Engineers' Club of Baltimore, Baltimore, Md.

Engineers' Club of Minneapolis, 17 South Sixth Street, Minneapolis, Minn.

Engineers' Club of Philadelphia, 1317 Spruce Street, Philadelphia, Pa.

Engineers' Club of St. Louis, 3817 Olive Street, St. Louis, Mo.

Engineers' Club of Toronto, 96 King Street, West, Toronto, Ont., Canada.

Engineers' Society of Northeastern Pennsylvania, 302 Board of Trade Building, Scranton, Pa.

Engineers' Society of Pennsylvania, 219 Market Street, Harrisburg, Pa.

Engineers' Society of Western Pennsylvania, 2511 Oliver Building, Pittsburg, Pa.

Institute of Marine Engineers, 58 Romford Road, Stratford, London, E., England.

Institution of Engineers of the River Plate, Buenos Aires, Argentine Republic.

Institute of Naval Architects, 5 Adelphi Terrace, London, W. C., England.

Junior Institution of Engineers, 39 Victoria Street, Westminster, S. W., London, England.

Koninklijk Instituut van Ingenieurs, The Hague, The Netherlands.

Louisiana Engineering Society, 321 Hibernia Bank Building, New Orleans, La.

Memphis Engineering Society, Memphis, Tenn.

Midland Institute of Mining, Civil and Mechanical Engineers, Sheffield, England.

Montana Society of Engineers, Butte, Montana.

North of England Institute of Mining and Mechanical Engineers, Newcastle-upon-Tyne, England.

Oesterreichischer Ingenieur= und Architekten=Verein, Eschenbachgasse 9, Vienna, Austria.

Pacific Northwest Society of Engineers, 803 Central Building, Seattle, Wash.

Rochester Engineering Society, Rochester, N. Y.

Sachsischer Ingenieur= und Architekten=Verein, Dresden, Germany.

Sociedad Colombiana de Ingenieros, Bogota, Colombia.

Sociedad de Ingenieros del Peru, Lima, Peru.

Societe des Ingenieurs Civils de France, 19 Rue Blanche, Paris, France.

Society of Engineers, 17 Victoria Street, Westminster, S. W., London, England.

Svenska Teknologforeningen, Brunkebergstorg 18, Stockholm, Sweden.

Tekniske Forening, Vestre Boulevard 18–1, Copenhagen, Denmark.

Western Society of Engineers, 1737 Monadnock Block, Chicago, Ill.

ACCESSIONS TO THE LIBRARY

(From August 2d to September 12th, 1911)

DONATIONS *

GOVERNMENT OWNERSHIP OF RAILWAYS

Considered as the Next Great Step in American Progress. By Anthony Van Wagenen. Cloth, 7½ x 5¼ in., 9 + 256 pp. New York and London, G. P. Putnam's Sons, 1910. $1.25.

The author states that this book is a plain history of the growth of public ownership from the time the Belgian Government began the building of railroads to the present day, and that it is written for the general reader. Few tables or statistics are given, and the author hopes that the book will stimulate public discussion of the subject. The Chapter headings are: Introduction; Ownership and Operation of Railways a Legitimate Function of Government; Weakness of Private Management; The Principle of Freight Rate-Making, Known as "Charging What the Traffic will Bear"; Will the Government be as Enterprising as Private Corporations Have Been in Extending the Service of the Railways; What Successful Government Control Would Mean; Government Ownership and Federal Patronage; Is Government Ownership Socialism; Government Ownership and States' Rights; How Government Ownership Affects the Laboring Man; The Mortality of Private Ownership; Freight Rates Under Government Ownership; Are Freight Rates Higher Under Government Ownership; Tapering Rates; The Unsoundness of Some of the Arguments Against Government Ownership; Railway Consolidation; The Source of Railway Political Power; Is Government Ownership Satisfactory Where It Has Been Tried; No Danger of Bankruptcy in Owning the Railroads; The Real Danger of Bankruptcy; Our Great Mileage and the Corresponding Magnitude of the Deal; Progress and Chronology of Government Ownership; Procrastination; Need of Immediate Action; Index.

THE TESTING OF ENGINES, BOILERS, AND AUXILIARY MACHINERY.

A Treatise on the Construction and Use of the Instruments and Methods Employed in the Testing of Prime Movers in the Laboratory and Workshop. By W. W. F. Pullen. Second Edition. Cloth, 9 x 6 in., illus., 730 pp. Manchester, England, The Scientific Publishing Company, 1911. 12 shillings 6 pence.

The first edition of this work was published in 1900 under the title "Experimental Engineering." For this, the second edition, it is stated, that the subject-matter has been re-written and many new illustrations have been added representing the latest and most useful apparatus. The author states that the object of the book is to place before engineers and students a detailed account of some of the methods of carrying out experiments on engines, boilers, and their auxiliary machinery, together with a description of the apparatus used. The first chapters are devoted to explanations of the theoretical work on which calculating and averaging instruments are based, in order to instruct the operator as to their principles. These are followed by a review of the necessary instruments used in the chief experiments and the directions in which they may be misused and misapplied. The book concludes with a description of the installations and a few experiments which may be made on motive-power machinery. The Contents are: Tables and Other Data; Mechanical Aids to Calculation; Measurement of Pressure; Measurement of Temperature; Measurement of Speed; Measurement of Power Output; Measurement of Power Input with Dynamometer; Measurement of Power Input with Indicator; Indicator Rigs and Accessories; Hints on the Management of Indicators; Analysis of the Steam Engine Diagram; Other Features of Steam Engine Diagrams; The Adjustment of the Slide Valve; Internal-Combustion Engine Diagrams; Testing Indicator Springs; Measurement of the Quality of Steam; Measurement of Quantity of Steam and Water; The Testing of Steam Engines; Fuel Testing; The Analysis of Flue Gases; Boiler Testing; The Testing of Auxiliary Machinery; The Testing of Internal Combustion Engines; Index.

A TREATISE ON THE DESIGN AND CONSTRUCTION OF MILL BUILDINGS

And Other Industrial Plants. By Henry Grattan Tyrrell. Cloth, 9¼ x 6¼ in., illus., 15 + 490 pp. Chicago and New York, The Myron C. Clark Publishing Co.; London, E. & F. N. Spon, Ltd., 1911. $4.00.

This work is stated to be the outcome of the author's "Mill Building Construction," published in 1900. Both books are based, it is said, on personal ex-

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*Unless otherwise specified, books in this list have been donated by the publishers.

periences in designing and estimating buildings, bridges, and other structural work, covering a period of twenty years. In Part I, Theory of Economic Design, the author considers the general features of a building, including its size, shape, dimensions, arrangement and location of machinery, roof covering, draining, lighting, ventilation, etc. A table of required wall thicknesses according to the building laws of various cities, is given, together with comparative estimated costs of different kinds of manufacturing buildings. In Part II, Loads, the dead and live loads are stated to be considered in detail, tables of weights being also included. In Part III, Framing, the chapters on Wood Framing and Concrete Framing are short and consist chiefly of illustrations, these subjects, it is stated, being discussed in detail in various recent treatises. This part includes chapters on Steel Framing and Northern Light Roof Framing, in which these subjects are discussed in detail. The author states that he has purposely omitted chapters on Graphic Statics and Calculations, which are fully treated in other books. In Part IV, Details of Construction, the chapter on Ground Floors, which the author states is important and about which there is little available literature, is well illustrated. Part IV also contains several chapters on paints and painting for the preservation of materials in modern manufacturing plants. Part V, Engineering and Drafting Departments of Structural Works, which is stated to have been prepared especially for students, estimators, and draftsmen, includes chapters on the organization and office methods of these departments, and the estimation of quantities and costs, including a table of wages paid to mechanics in the building trades in various cities of the United States in 1910, and also a chapter on Directions for Exporting Steel Buildings.

THE PUBLIC HEALTH MOVEMENT.

The Annals of the American Academy of Political and Social Science, Vol. XXXVII, No. 2, March, 1911. Emory R. Johnson, Editor. Paper, 10 x 7 in., 334 pp. Philadelphia, American Academy of Political and Social Science, 1911. $1.00.

The Contents are: Part I, The General Problem: Health Needs and Civic Action, by William H. Allen; Housing and Health, by Lawrence Veiller; Scientific Research by the Public Health Service, by J. W. Kerr; The Census and the Public Health Movement, by Cressy L. Wilbur; Sources of Information Upon the Public Health Movement, by Robert Emmet Chaddock; Work of the Committee of One Hundred on National Health, by Wm. Jay Schieffelin; Public Health Movement on the Pacific Coast, by Sarah I. Shuey; Protecting Public Health in Pennsylvania, by Samuel G. Dixon; Health Problems of the Indians, by Joseph A. Murphy; Health Problems of the Negroes, by John A. Kenney. Part II, Disease Carriers—The Control of Causes: The Rural Health Movement, by Ch. Wardell Stiles; Sanitation in Rural Communities, by Charles E. North; Tropical Diseases and Health in the United States, by John M. Swan; The House Fly as a Carrier of Disease, by Edward Hatch, Jr.; The Mosquito Campaign as a Sanitary Measure, by John B. Smith; Clean Milk and Public Health, by Jesse D. Burks; Ventilation and Public Health, by D. D. Kimball. Part III, Elimination of Diseases—Physical Care of Individuals: Social Service Work in Hospitals, by Richard C. Cabot; Mouth Hygiene and Its Relation to Health, by Arthur H. Merritt; The Physical Care of Children, by Walter S. Cornell; What American Cities are Doing for the Health of School Children, by Leonard P. Ayres; The Elimination of Feeble-Mindedness, by Henry Herbert Goddard; Prevention of Infantile Blindness, by Charles F. F. Campbell; The Warfare Against Infant Mortality, by S. W. Newmayer.

Gifts have also been received from the following:

Aldershot Gas, Water & Dist. Lighting Co. 1 pam.
Alexandra (Newport & South Wales) Docks & Ry. Co. 1 pam.
Am. Inst. of Elec. Engrs. 2 bound vol.
Assoc. of Transportation and Car Accounting Officers. 1 pam.
Auburn, N. Y.-Water Board. 1 pam.
Bangor, Me.-Water Board. 1 pam.
Berlin Kgl. Technische Hochschule. 2 pam.
Boston, Mass.-City Auditor. 1 bound vol.
Boston, Mass.-Dept. of Parks. 1 pam.
Boston, Mass., Chamber of Commerce. 1 pam.
British Assoc. for the Advancement of Sci. 1 bound vol.
Brooklyn Public Library. 1 pam.
Buffalo, N. Y.-Grade Crossing Comm. 1 pam.
Buffalo, N. Y., Chamber of Commerce. 1 pam.
Caird, James M. 1 pam.
California-State Board of Health. 1 vol.
California-State Harbor Commrs. for the Port of Eureka. 1 pam.
Cambrian Rys. Co. 1 pam.
Canadian Inst. 1 pam.
Central London Ry. Co. 1 pam.
Central of Georgia Ry. Co. 1 pam.
Central States Water-Works Assoc. 8 pam.
Chicago, Ill.-City Clerk. 1 pam.
Chicago, Ill.-Dept. of Health. 1 vol.
Chicago, Ill., Bureau of Public Efficiency. 1 pam.
Cincinnati, Ohio-Water Dept. 1 pam.
Clarke, David D. 1 bound vol.
Colorado-Bureau of Mines. 1 bound vol.

Colorado-State Board of Equalization. 1 bound vol.
Colorado-State Board of Health. 1 bound vol., 3 vol.
Colorado School of Mines. 4 pam.
Colorado, Univ. of. 1 vol.
Connecticut-Rivers and Harbors Comm. 1 pam.
Connecticut-State Board of Health. 1 bound vol., 1 pam.
Connecticut Soc. of Civ. Engrs. 1 pam.
Connecticut State Business Men's Assoc. 1 pam.
Danzig Kgl. Technische Hochschule. 1 pam.
Denver & Rio Grande R. R. Co. 1 pam.
Dyckerhoff & Söhne. 1 vol.
Egypt-Gen. Mgr. of State Rys. and Telegraphs. 1 pam.
Eiffel, Gustave. 1 pam.
Florida-State Board of Health. 3 pam.
Florida-State Geol. Survey. 1 bound vol.
Furness Ry. Co. 1 pam.
Geneva, N. Y.-Board of Public Works. 1 pam.
Great Britain-Patent Office. 7 vol.
Great Central Ry. Co. 2 pam.
Great Northern & City Ry. Co. 1 pam.
Great Northern Ry. Co. (Ireland). 1 pam.
Great Western Ry. Co. 1 pam.
Hartford, Conn.-Dept. of Eng. 1 pam.
Hawaii-Board of Commrs. of Agri. and Forestry. 1 vol.
Higgins, George. 1 pam.
Hill, Cicero D. 1 pam.
Historical Soc. of Pennsylvania. 1 vol.
Hull & Barnsley Ry. Co. 1 pam.
Illinois-Bureau of Labor Statistics. 1 pam.
Illinois-Comm. on Occupational Diseases. 1 vol.
Illinois-Park Comm. 1 pam.
Illinois-Special Tax Comm. 1 vol., 1 pam.
India-Ry. Board. 1 vol.
Indiana-R. R. Comm. 1 bound vol.
Indiana-State Board of Forestry. 2 bound vol.
Indiana-State Insp. of Mines. 1 pam.
Indiana-State Library. 3 pam.
Inst. of Marine Engrs. 1 bound vol.
Institution of Civ. Engrs. 1 bound vol.
Institution of Min. Engrs. 1 pam.
Instituto Italiano d'Arti Grafiche. 1 bound vol.
Iowa-Gen. Assembly. 1 pam.
Iowa-Secy. of State. 1 bound vol.
Iron and Steel Inst. 1 bound vol.
Kansas-Board of R. R. Commrs. 1 bound vol., 1 vol.
Kansas-State Board of Agri. 1 pam.
King & King. 1 pam.
Kirkpatrick, Walter G. 1 pam.
Lake Mohonk Conference on Inter. Arbitration. 1 pam.
Lake Superior Min. Inst. 1 pam.
Liverpool Overhead Ry. Co. 1 pam.
London, England-Met. Water Board. 1 pam.
London Elec. Ry. Co. 1 pam.
London, Tilbury & Southend Ry. Co. 1 pam.
Louisiana State Univ. 1 pam.
Madison, Wis.-City Clerk. 1 bound vol.
Maine-State Water Storage Comm. 1 bound vol., 5 pam.
Maryland-State Board of Forestry. 1 pam.
Maryport & Carlisle Ry. Co. 1 pam.
Massachusetts-Met. Impvt. Comm. 1 bound vol.
Massachusetts-Mount Everett State Reservation Comm. 1 pam.
Massachusetts-State Board of Health. 6 pam.
Massachusetts-Wachusett Mountain State Reservation Comm. 6 pam.
Metcalf & Eddy. 1 pam.
Michigan-Legislature. 1 bound vol.
Michigan-Secy. of State. 2 bound vol.
Michigan-State Highway Commr. 2 bound vol.
Michigan-State Insp. of Illuminating Oils. 3 bound vol., 1 pam.
Michigan Coll. of Mines. 1 pam.
Midland & South Western Junction Ry. Co. 1 pam.
Midland Ry. Co. 1 pam.
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Composition and Heat Treatment of Steel. By E. F. Lake. Second Edition, Revised and Corrected. McGraw-Hill Book Company, New York and London, 1911.

Principles of Industrial Engineering. By Charles Buxton Going. McGraw-Hill Book Company, New York and London, 1911.

Seehafenbau. Von F. W. Otto Schulze. Band I, Allgemeine Anordnung der Seehäfen. Wilhelm Ernst & Sohn, Berlin, 1911.

Der Städtische Tiefbau: Band II, Die Wasserversorgung der Städte; Zweite Abteilung, Einzelbestandteile der Wasserleitungen. Von Otto Lueger und Ernst Fischer. Alfred Kröner, Leipzig, 1908.

The Analysis of Paints and Painting Materials. By Henry A. Gardner and John A. Schaeffer. McGraw-Hill Book Company, New York and London, 1911.

Modern Methods of Sewage Purification: A Guide for the Designing and Maintenance of Sewage Purification Works. By G. Bertram Kershaw. Charles Griffin & Company, Limited, London, 1911.

The Mineral Industry: Its Statistics, Technology, and Trade During 1910. Edited by Albert Hill Fay. Vol. XIX. McGraw-Hill Book Company, New York and London, 1911.

Muret-Sanders Encyklopädisches Wörterbuch der Englischen und Deutschen Sprache. Teil 2, Deutschenglisch, A–J, K–Z. H. Grevel & Co., London; The International News Company, New York, 1905.

Werner von Siemens, Ein Bahnbrecher in der Wissenschaft, Technik und Ethik: Ein Volksabend. Von Ottomar Beta. Friedrich Emil Perthes, Gotha, 1910.

Proceedings of the International Association for Testing Materials, Vol. II, No. 4. McGraw-Hill Book Co., New York; E. & F. N. Spon, Limited, London, 1911.

Mitteilungen über Forschungsarbeiten auf dem Gebiete des Ingenieurwesens, insbesondere aus den Laboratorien der technischen Hochschulen. Herausgegeben vom Verein deutscher Ingenieure. Hefte 101, 102, 103, 104. Julius Springer, Berlin, 1911.

Handbuch der Ingenieurwissenschaften: Pt. I, Vol. 1–3; Pt. V, Vol. 1, 8. Pt. I, Vorarbeiten, Erd-, Grund-, Strassen- und Tunnelbau, von L. von Willmann: Vol. 1, Vorarbeiten für Eisenbahnen und Strassen, Bauleitung, von L. Oberschulte und H. Wegele; Vol. 2, Erd- und Felsarbeiten, Erdrutschungen, Stütz- und Futtermauern, von E. Häseler, H. Wegele und L. von Willmann; Vol. 3, Der Grundbau, von L. von Willmann und C. Zschokke. Pt. V, Der Eisenbahnbau, Ausgenommen Vorarbeiten, Unterbau und Tunnelbau, von F. Loewe und H. Zimmermann: Vol. 1, Einleitung und Allgemeines, Bahn und Fahrzeug im Allgemeinen, von Alfred Birk; Vol. 8, Lokomotiv-Steilbahnen und Seilbahnen, von Roman Abt und Siegfried Abt. Wilhelm Engelmann, Leipzig, 1904–08.

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HOLMES, ROBERT LESLIE. Div. Engr., Tex. & Pac. Ry. Co., Marshall, Tex.

HOLMES, THOMAS HUGHES. Broadway and Crosby St., Portland, Ore.

HUBBARD, DANIEL. Office Res. Engr., B. & O. R. R. Co., Meyersdale, Pa.

HUGHES, NORMAN. 253 Freemason St., Norfolk, Va.

HUGHES, WILLIAM RICHARD, JR. Care, C. M. Neeld Constr. Co., 1418 Oliver Bldg., Pittsburg, Pa.

JUNIORS (*Continued*)

KINGSLEY, GEORGE. 960 Fox St., New York City.

LETTON, HARRY PIKE. Field Asst., Dept. of Sewerage and Water Supplies, State Board of Health, 213 East Hanover St., Trenton, N. J.

LOUGHRAN, HAROLD SCOTT. Hillcrest Ave., New Rochelle, N. Y.

MARTINEZ, ROLANDO ARNOLDO. Malecon 31, Bajos, Havana, Cuba.

MENKE, WILLIAM. 3 West 63d St., New York City.

MIETH, RICHARD ELAM. 923 Yeon Bldg., Portland, Ore.

NEUHARDT, EDWIN. Designing Draftsman, Constr. Dept., Brooklyn Union Gas Co., Brooklyn, N. Y. (Res., 505 West 124th St., New York City).

NEWTON, GEORGE CHENEY. Engr., Newton Eng. Co., 434 Jackson St., Milwaukee, Wis.

OVEROCKER, DANIEL WILLETS. Asst. Engr., Barge Canal Office, Canajoharie, N. Y.

PAINE, GEORGE HEBARD. 1311 Morse Ave., Chicago, Ill.

PARKER, KINGSBURY EASTMAN. 645 Monadnock Bldg., San Francisco, Cal.

REESE, GEORGE WASHINGTON. U. S. Junior Engr., P. O. Box 398, Walden, N. Y.

REYNOLDS, LEON BENEDICT. 519 East State St., Ithaca, N. Y.

RICHARDS, ARTHUR. 407 Franklin Ave., Wilkinsburg, Pa.

SACKETT, ARTHUR JOHNSON. Cornwall-on-Hudson, N. Y.

SAXE, VAN RENSSELAER POWELL. Vice-Pres., Standard Concrete Steel Co., 218 East Lexington St., Baltimore, Md.

SCHMIDT, THEODORE JOHN. Care, Standard Bridge Co., Omaha, Nebr.

SCOTT, JAMES ROBINSON, JR. Masonry Insp., Ill. Cent. R. R. Co., Bridge and Bldg. Dept., 507 South State St., Champaign, Ill.

SMITH, ELROY GEORGE. P. O. Box 576, Augusta, Ga.

TEAL, JONATHAN ERNEST. Asst. Engr., Operating Dept., B. & O. R. R., B. & O. Bldg., Baltimore, Md.

TILLIT, PEDRO ERNESTO. Care, Peruvian Consulate, 25 Broad St., New York City.

TURNER, CHARLES RUSSELL. U. S. Deputy Mineral Surv., Care, Mrs. Charles P. Turner, Cliftondale, Mass.

VOLCK, ADALBERT GEORGE. The Plaza, New York City.

WARRACK, JAMES BALDWIN. Supt. of Constr., Northern Hospital for the Insane, Sedro-Wooley, Wash.

WATSON, GEORGE LINTON. Cons. Engr., Engineers' Club, Philadelphia, Pa.

WEBER, DANIEL RISHEL. Care, U. S. Reclamation Service, Indian Creek Dike, Thistle, Utah.

WRIGHT, THOMAS JUDSON, JR. 212 Trust Bldg., Charlotte, N. C.

RESIGNATIONS

ASSOCIATE MEMBERS	Date of Resignation.
MACKENZIE, GEORGE BURDICK	Sept. 5, 1911
MUNN, MORTIMER ADAM	Sept. 5, 1911

DEATHS

CHRISTIE, JAMES. Elected Member May 7th, 1873; died August 24th, 1911.

COLLINGWOOD, FRANCIS. Elected Member March 3d, 1869; died August 18th, 1911.

FRAZER, JOSEPH HECKART. Elected Junior March 31st, 1908; date of death unknown.

HAZEN, RICHARD. Elected Junior, November 8th, 1909; died August 13th, 1911.

PIERCE, HENRY. Elected Member December 5th, 1894; died August 21st, 1911.

TAYLOR, WILLIAM DANA. Elected Member March 1st, 1899; died August 26th, 1911.

Total Membership of the Society, September 12th, 1911,
6 159.

MONTHLY LIST OF RECENT ENGINEERING ARTICLES OF INTEREST

(August 8th to September 9th, 1911)

NOTE.—*This list is published for the purpose of placing before the members of the Society, the titles of current engineering articles, which can be referred to in any available engineering library, or can be procured by addressing the publication directly, the address and price being given wherever possible.*

LIST OF PUBLICATIONS

In the subjoined list of articles, references are given by the number prefixed to each journal in this list:

(1) *Journal*, Assoc. Eng. Soc., 31 Milk St., Boston, Mass., 30c.
(2) *Proceedings*, Engrs. Club of Phila., 1317 Spruce St., Philadelphia, Pa.
(3) *Journal*, Franklin Inst., Philadelphia, Pa., 50c.
(4) *Journal*, Western Soc. of Engrs., Monadnock Blk., Chicago, Ill.
(5) *Transactions*, Can. Soc. C. E., Montreal, Que., Canada.
(6) *School of Mines Quarterly*, Columbia Univ., New York City, 50c.
(8) *Stevens Institute Indicator*, Stevens Inst., Hoboken, N. J., 50c.
(9) *Engineering Magazine*, New York City, 25c.
(10) *Cassier's Magazine*, New York City, 25c.
(11) *Engineering* (London), W. H. Wiley, New York City, 25c.
(12) *The Engineer* (London), International News Co., New York City, 35c.
(13) *Engineering News*, New York City, 15c.
(14) *The Engineering Record*, New York City, 12c.
(15) *Railway Age Gazette*, New York City, 15c.
(16) *Engineering and Mining Journal*, New York City, 15c.
(17) *Electric Railway Journal*, New York City, 10c.
(18) *Railway and Engineering Review*, Chicago, Ill., 10c.
(19) *Scientific American Supplement*, New York City, 10c.
(20) *Iron Age*, New York City, 10c.
(21) *Railway Engineer*, London, England, 25c.
(22) *Iron and Coal Trades Review*, London, England, 25c.
(23) *Bulletin*, American Iron and Steel Assoc., Philadelphia, Pa.
(24) *American Gas Light Journal*, New York City, 10c.
(25) *American Engineer*, New York City, 20c.
(26) *Electrical Review*, London, England.
(27) *Electrical* World, New York City, 10c.
(28) *Journal*, New England Water-Works Assoc., Boston, Mass., $1.
(29) *Journal*, Royal Society of Arts, London, England, 15c.
(30) *Annales des Travaux Publics de Belgique*, Brussels, Belgium.
(31) *Annales* de l'Assoc. des Ing. Sortis des Ecoles Spéciales de Gand, Brussels, Belgium.
(32) *Mémoires et Compte Rendu des Travaux*, Soc. Ing. Civ. de France, Paris, France.
(33) *Le Génie Civil*, Paris, France.
(34) *Portefeuille Economiques des Machines*, Paris, France.
(35) *Nouvelles Annales de la Construction*, Paris, France.
(37) *Revue de Mécanique*, Paris, France.
(38) *Revue Générale des Chemins de Fer et des Tramways*, Paris, France.
(41) *Modern Machinery*, Chicago, Ill., 10c.
(42) *Proceedings*, Am. Inst. Elec. Engrs., New York City, 50c.
(43) *Annales des Ponts et Chaussées*, Paris, France.
(44) *Journal*, Military Service Institution, Governors Island, New York Harbor, 50c.
(45) *Mines and Minerals*, Scranton, Pa., 20c.
(46) *Scientific American*, New York City, 8c.
(47) *Mechanical Engineer*, Manchester, England.
(48) *Zeitschrift*, Verein Deutscher Ingenieure, Berlin, Germany.
(49) *Zeitschrift für Bauwesen*, Berlin, Germany.
(50) *Stahl und Eisen*, Düsseldorf, Germany.
(51) *Deutsche Bauzeitung*, Berlin, Germany.
(52) *Rigasche Industrie-Zeitung*, Riga, Russia.
(53) *Zeitschrift*, Oesterreichischer Ingenieur und Architekten Verein, Vienna, Austria.
(54) *Transactions*, Am. Soc. C. E., New York City, $4.
(55) *Transactions*, Am. Soc. M. E., New York City, $10.
(56) *Transactions*, Am. Inst. Min. Engrs., New York City, $5.
(57) *Colliery Guardian*, London, England.

(58) *Proceedings,* Engrs.' Soc. W. Pa., 803 Fulton Bldg., Pittsburg, Pa., 50c.
(59) *Transactions,* Mining Inst. of Scotland, London and Newcastle-upon-Tyne, England.
(60) *Municipal Engineering,* Indianapolis, Ind., 25c.
(61) *Proceedings,* Western Railway Club, 225 Dearborn St., Chicago, Ill., 25c.
(62) *Industrial World,* 59 Ninth St., Pittsburg, Pa.
(63) *Minutes of Proceedings,* Inst. C. E., London, England.
(64) *Power,* New York City, 20c.
(65) *Official Proceedings,* New York Railroad Club, Brooklyn, N. Y., 15c.
(66) *Journal of Gas Lighting,* London, England, 15c.
(67) *Cement and Engineering News,* Chicago, Ill., 25c.
(68) *Mining Journal,* London, England.
(70) *Engineering Review,* New York City, 10c.
(71) *Journal,* Iron and Steel Inst., London, England.
(71*a*) *Carnegie Scholarship Memoirs,* Iron and Steel Inst., London, England.
(73) *Electrician,* London, England, 18c.
(74) *Transactions,* Inst. of Min. and Metal., London, England.
(75) *Proceedings,* Inst. of Mech. Engrs., London, England.
(76) *Brick,* Chicago, Ill., 10c.
(77) *Journal,* Inst. Elec. Engrs., London, England.
(78) *Beton und Eisen,* Vienna, Austria.
(79) *Forscherarbeiten,* Vienna, Austria.
(80) *Tonindustrie Zeitung,* Berlin, Germany.
(81) *Zeitschrift für Architektur und Ingenieurwesen,* Wiesbaden, Germany.
(83) *Progressive Age,* New York City, 15c.
(84) *Le Ciment,* Paris, France.
(85) *Proceedings* Am. Ry. Eng. and M. of W. Assoc., Chicago, Ill.
(86) *Engineering-Contracting,* Chicago, Ill., 10c.
(87) *Roadmaster and Foreman,* Chicago, Ill., 10c.
(88) *Bulletin* of the International Ry. Congress Assoc., Brussels, Belgium.
(89) *Proceedings,* Am. Soc. for Testing Materials, Philadelphia, Pa.
(90) *Transactions,* Inst. of Naval Archts., London, England.
(91) *Transactions,* Soc. Naval Archts. and Marine Engrs., New York City.
(92) *Bulletin,* Soc. d'Encouragement pour l'Industrie Nationale, Paris, France.
(93) *Revue de Métallurgie,* Paris, France, 4 fr. 50.
(94) *The Boiler Maker,* New York City, 10c.
(95) *International Marine Engineering,* New York City, 20c.
(96) *Canadian Engineer,* Toronto, Ont., Canada, 15c.
(97) *Turbine,* Berlin, Germany. 1 Mark.
(98) *Journal,* Engrs. Soc. Pa., 219 Market St., Harrisburg, Pa., 30c.
(99) *Proceedings,* Am. Soc. of Municipal Improvements, New York City, $1.50.
(100) *Professional Memoirs,* Corps of Engrs., U. S. A., Washington, D. C., $1.
(101) *Metal Worker,* New York City, 10c.
(102) *Organ für die Fortschritte des Eisenbahnwesens,* Wiesbaden, Germany.
(103) *Mining and Scientific Press,* San Francisco, Cal., 10c.
(104) *The Surveyor and Municipal and County Engineer,* London, England, 6d.
(105) *Metallurgical and Chemical Engineering,* New York City, 25c.
(106) *Transactions,* Inst. of Mining Engrs., London, England, 6 shillings.
(107) *Schweizerische Bauzeitung,* Zurich, Switzerland.
(108) *Southern Machinery,* Atlanta, Ga., 10c.

LIST OF ARTICLES.

Bridges.

The Pittsburg and Lake Erie Railroad Cantilever Bridge Over the Ohio River at Beaver, Pa.* Albert R. Raymer, M. Am. Soc. C. E. (54) Vol. 73.
The Necessity of Steel Highway Bridge Inspection, Investigation and Maintenance. N. B. Carver. (From the *Iowa Engineer.*) (96) Aug. 3.
The Old Essex-Merrimac Chain Suspension Bridge at Newburyport, Mass., and Tests of Its Wrought-Iron Links After 100 Years' Service.* A. P. Mills. (Abstract from *Cornell Civil Engr.*) (13) Aug. 3.
Substructure of the Kentucky and Indiana Bridge.* (15) Aug. 4.
Schemes of Erection Proposed for the Quebec Bridge.* (13) Aug. 10.
Erection of Opossum Creek and Beaver Creek Viaducts.* (14) Aug. 12.
Quebec Bridge Caissons.* (14) Aug. 12; (12) Aug. 18.
The Construction of the Kuskulana River Bridge, Alaska.* A. C. O'Neel. (14) Aug. 12.
The Erection of the Naugatuck Bridge.* (14) Aug. 19.
The Architectural Features of St. Paul's Bridge. (14) Aug. 19.
A Double-Track Skew Bridge with Solid Floor.* (14) Aug. 19.
American Practice in General Type and Clearance of Bridges in Grade Separation Work. Robert H. Whitman. (86) Aug. 23.

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*Illustrated.

Bridges—(Continued).

A Highway and Electric Car Crossing over Railroad Tracks.* (14) Aug. 26.
Standard Plans and Specifications for Timber Trestles, Seattle, Wash.* R. H. Thomson. (86) Aug. 30.
The Crossing of the Western Maryland R. R. over the Pennsylvania R. R. near Connellsville, Pa.* (13) Aug. 31.
Pont en Béton Armé Construit sur la Meuse à Hermalle sous Huy.* C. Houart. (30) Aug.
Le Pont en Béton Armé, en Bow-String, de Montesquieu (Haute-Garonne).* Alfred Jacobson. (33) Aug. 5.
Bogen mit starkem Schub.* Adolf Francke. (81) Pt. 5.
Die Blackwells-Insel Brücke über den Ost-Fluss in Newyork.* G. Barkhausen. (48) Serial beginning July 29.
Last (Raddruck-) verteilung bei Fahrbahntafeln aus Eisenbeton und die Vorschriften für Oesterreich.* M. Gatterer. (78) Aug. 4.
Versuche mit Druckstäben aus Nickelstahl.* F. Bohny. (50) Aug. 10.
Strassenbrücke über den neuen Kieler Güterbahnhof.* Viktor Mautner. (78) Serial beginning Aug. 24.
Die Brücke der "Wiedergeburt" über den Tiber in Rom (100 m Spannweite).* Theodor Gesteschi. (78) Serial beginning Aug. 24.
Der Wettbewerb um den Entwurf einer Strassenbrücke über den Rhein bei Köln.* Karl Bernhard. (48) Aug. 26.

Electrical.

Electricity Meters, with Notes on Meter Testing.* H. A. Ratcliff and A. E. Moore. (77) July.
Wireless Telegraphy in Relation to Interferences and Perturbations.* J. E. Taylor. (77) July.
The Electrical Undertaking of the Birmingham Tame and Rea District Drainage Board.* L. F. Mountfort. (77) July.
Electric Heating as Applied to Cooking Apparatus. Harold Gray. (77) July.
Some Considerations Relating to the Parallel Working of Alternators.* James R. Barr. (77) July.
Vibrating Wires and the Measurement of Distance.* C. A. Smith, A. Am. I. Elec. E. (26) July 28.
Some Protective Relays for Alternating-Current Circuits.* Kenelm Edgcumbe. (26) Serial beginning July 28.
The Electrical Equipment of the S. S. *Olympic* and *Titanic*.* (73) Serial beginning July 28.
Apparatus for Charging Storage Batteries.* H. K. Ferguson, R. E. Russell and E. E. Kimball. (87) Aug.
Transmission System of the Central Colorado Power Co.* P. T. Hanscom. (42) Aug.
Problems in Telephone Traffic Engineering.* F. P. Valentine. (42) Aug.
Balancing the Rotors of Turbo-Generators.* J. W. Rogers. (10) Aug.
Main Substation of the Metropolitan Electric Company at Reading, Pa.* (27) Aug. 5; (64) Aug. 15.
Application of Motor Drive to Brick Plants.* Gordon Weaver. (27) Aug. 5.
"By-Product" Electric-Light Plants.* George H. Morse. (Paper read before the Nebraska Elec. Assoc.) (27) Aug. 5.
Electric Lighting from Three-Phase Circuits.* G. P. Hoxie. (27) Aug. 5.
Extension of Redondo Beach Plant.* A. R. Maujer. (64) Aug. 8.
Electricity Supply at Marseilles.* (73) Aug. 11.
Hydroelectric Development in Northern Ontario.* (27) Aug. 12.
Regenerative Control from a Commercial Viewpoint.* Gustaf V. Lang. (27) Aug. 12.
The Manufacture of Drawn Tungsten Filament Lamps.* (11) Aug. 18.
Dubilier Wireless Telegraph Station at Seattle.* (73) Aug. 18.
The Power Required to Cut Steel. P. V. Vernon. (12) Aug. 18.
New Type of Storage Battery Car.* (17) Aug. 19.
Modern English Power Plant.* (64) Aug. 22.
The B. T.-H. Co.'s Tungsten Lamp Works.* (26) Aug. 25.
Another French Diesel Marine Motor.* (12) Aug. 25.
The Method of Constant Rate of Change of Flux as a Standard for Determining Magnetisation Curves of Iron.* J. T. Morris and T. H. Langford. (Abstract of paper read before the Physical Soc.) (73) Aug. 25.
Efficiency in the Electrolytic Production of Metallic Calcium. F. C. Frary, H. R. Bicknell and C. A. Tronson. (Abstract of paper read before the Am. Electrochemical Soc.) (73) Aug. 25.
The Electrical Preciptation of Suspended Particles.* F. G. Cottrell. (103) Serial beginning Aug. 26.
Northwestern Terminal in Chicago.* (27) Aug. 26.
The Electric *vs.* the Gasoline Vehicle. Hayden Eames. (27) Aug. 26.
Overhead Standardization. A. Schlessinger. (Paper read before the Central Electric Ry. Assoc.) (17) Aug. 26.

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*Illustrated.

Electrical—(Continued).

Selection of Alternating-Current Motors for Elevator Service.* A. G. Popcke (From *Electric Journal.*) (62) Aug. 28.
Plum Street Generating Station.* (64) Aug. 29.
Automatic Electric Motor Control by a Novel Magnetic Switch.* (13) Aug. 31.
Rates of the Queensborough Gas & Electric Co.; the First Commodity-Rate Case of the Public Service Commission for the First District of New York. (13) Aug. 31.
Responsibilities of Electrical Engineers in Making Appraisals. H. M. Byllesby. (42) Sept.
Cost of Power; Conversion Factors. Carl Hering. (105) Sept.
The Use of Prepayment Electric Meters.* F. G. Vaughen. (3) Sept.
The Combined Water Works, Electric Light and Ice Plant at Loveland, Ohio.* Frank C. Perkins. (60) Sept.
The Selection of Direct-Current Motors for Factory Use. Earle D. Jackson. (9) Sept.
The Magician Dynamo for Car Lighting.* (73) Sept. 1.
Electrical Power Installation at the Alquife Iron Ore Mines.* (22) Sept. 1.
Combination Heating and Generating Plant at Springfield, Ill.* (27) Sept. 2.
Downtown Arc-Lighting System of Philadelphia.* (27) Sept. 2.
Operation of Series Alternating-Current Street Arc Lamps.* J. C. Lawler. (27) Sept. 2.
Southern California Edison System.* A. R. Maujer. (64) Sept. 5.
A Swiss Transformer Station and Distributing Tower.* J. B. Van Brussel. (13) Sept. 7.
Les Progrès de la Télégraphie Ordinaire.* Lucien Fournier. (33) Serial beginning Aug. 26.

Marine.

The Stability of Ships.* B. C. Laws, A. M. Inst. C. E. (10) Aug.
A Floating Machine Shop and Foundry.* Paul Foley. (108) Aug.
Anticorrosive and Antifouling Paints for Ships' Bottoms; Experience of the U. S. Navy.* Henry Williams. (Abstract from U. S. Naval Inst. *Proceedings.*) (13) Aug. 3.
Curtis Turbines for the United States Destroyers *Sterrett* and *Perkins.* (11) Aug. 18.
The Laubeuf Submersible Boat.* (11) Aug. 18.
Shipbuilding Works at La Seyne.* (12) Aug. 25.
Another French Diesel Marine Motor.* (12) Aug. 25.
German Impulse Marine Turbines.* (12) Aug. 25.
The Submarine Vessel.* K. Dietze. (95) Serial beginning Sept.
A Twin Hatch Steamer with Central Deck Ballast Tank.* (95) Sept.
The Mystery of the *Maine.** Ludwig Diller. (46) Sept. 2; (9) Sept.; (95) Sept.
The Rolling of Ships. J. H. Biles. (Paper read before the British Assoc. for the Advancement of Sci.) (12) Sept. 1; (11) Sept. 1.
The New British Dreadnoughts.* (46) Sept. 9.
Les Canots Automobiles à l'Exposition de Kiel.* T. Claes et E. Marote. (30) Aug.
Ueber die Verkürzung der Auslaufzeit bei Kammerschleusen. Wilibald Liebisch. (53) Aug. 25.

Mechanical.

Operation of Boiler Plants of Industrial Works. John A. Hunter. (58) July.
Inverted Incandescent Gas Lighting.* Max Scholz. (Paper read before the Gas and Electric Engrs. of the Province of Brandenburg.) (66) July 25.
Detection of Inflammable Gas in Air. A. Philip, L. G. Steele, and Stenhouse. (Papers read before the Society of Chemical Industry.) (66) July 25.
Propellers for Flying Machines.* Herbert Chatley. (12) July 28.
A New Drill for Deep Holes.* George H. Gilman. (Abstract from *Mine and Quarry.*) (103) July 29.
Some Recent Developments in Testing.* F. W. Speller. (94) Aug.
Layout of a Hopper for a Concrete Mixer.* C. B. Lindstrom. (94) Aug.
Some Problems of the Cement Industry. Walter S. Landis. (67) Aug.
The Reduction of Power Losses.* Karl W. Knorr. (10) Aug.
The Driving of Cotton Mills.* W. H. Booth. (10) Aug.
Making Gasoline from Oil Well Gas.* F. W. Brady. (45) Aug.
Oils for Lubrication. C. E. Ward. (Paper read before the Coal Min. Inst. of America.) (45) Aug.
Aerial Tramways of the Balaklala Consolidated Copper Company.* William Hewitt. (10) Aug.
Furnaces and Fuel.* Ellis Lovejoy. (76) Aug. 1.
Bradford Pressed Brick, Economical Operation Effected by Use of Gas Engines at Two Large Plants of Bradford Pressed Brick Company.* (76) Aug. 1.

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*Illustrated.

Mechanical—(Continued).

Corrections for the Effects of Atmospheric Conditions on Different Photometric Flame Standards.* W. J. A. Butterfield, J. S. Haldane, and A. P. Trotter. (Paper read before the International Photometric Comm.) (66) Aug. 1; (24) Sept. 4.
Artificial Lighting of Hospitals. John Darch. (Paper read before the Royal Sanitary Inst. Congress.) (66) Aug. 1.
The Simonds Lockport Steel Mill.* (20) Aug. 3.
Steam Turbines.* H. Zoelly. (Paper read before the Inst. of Mech. Engrs.) (22) Aug. 4.
The Gas Driven Electric Generating Station of the Société des Mines de Lens.* (22) Aug. 4.
Making Dies for Forging Machines.* J. Martin. (Paper read before the Am. Railway Tool Foreman's Assoc.) (15) Aug. 4.
Notes on Street Lighting From a Practical Point of View.* H. E. Copp. (Paper read before the Institution of Mun. and County Engrs.) (104) Serial beginning Aug. 4.
"Soapy Water" Lubrication for Air Cylinders. J. Broad Roberts. (Abstract of paper read before the South African Inst. of Engrs.) (47) Aug. 4.
Cement Manufacture in Germany. Otto Schott. (Abstract of paper read before the Am. Portland Cement Manufacturers.) (103) Aug. 5.
Mail Handling Machinery at the Pennsylvania R. R. Terminal and New United States Post Office at New York City.* Julian E. Woodwell. (Abstract of paper read before the Mass. Inst. of Tech.) (18) Aug. 5.
Gas-Producer Plant Experience at Huron, S. D.* (27) Aug. 5.
A Grain Tester for Commercial Use.* J. W. T. Duvel. (19) Aug. 5.
The Aviation Motor.* Earle L. Ovington. (46) Aug. 5.
Some Unloading Costs. W. H. Matlack. (24) Aug. 7.
Installation of Small Stationary Engines.* John S. Leese. (64) Aug. 8.
The Berrigan Continuous Bucket-Chain Filter Press.* (13) Aug. 10.
Conveyors for Foundries.* Henry J. Edsall. (13) Aug. 10.
A Special Coal Handling Crane.* (20) Aug. 10.
The Mechanical Charging of Cupolas.* G. R. Brandon. (Paper read before the Am. Foundrymen's Assoc.) (47) Aug. 11.
Floating Jib-Crane for Spain.* (12) Aug. 11.
Smoke Prevention in Large Power Stations. Hervey S. Vasser. (Paper read before the Internat. Assoc. for the Prevention of Smoke.) (62) Aug. 14.
High Pressure Gas Plant with Medium Pressure on Mains.* F. H. Sawyer. (Paper read before the Southern Gas Assoc.) (24) Aug. 14.
The Inspection of Gas Consumers and Gas Appliances. F. G. Dean. (Paper read before the Southern Gas Assoc.) (24) Aug. 14.
The Mechanical Stoker *vs.* Hand Firing. Robert Cameron Beadle. (Paper read before the Internat. Assoc. for the Prevention of Smoke.) (62) Aug. 14.
Purchasing Oil and Gas by Sample. Irving C. Allen. (83) Aug. 15.
Developments in British Steam Plants.* James A. Seager. (64) Aug. 15.
New Gas Works for Guadalajara, Mexico.* W. A. Aldrich. (83) Aug. 15.
Investigation of Beloit Gas Rates. Frank A. Newton. (83) Aug. 15.
Placing Gas in a New Factory Building.* Everett M. Hawley. (83) Aug. 15.
The Uses of Coal Gas Appliances for Industrial Purposes. G. F. Hurst. (Paper read before the Irish Assoc. of Gas Managers.) (66) Aug. 15.
Recent Progress in Diesel Engines.* F. E. Junge. (64) Aug. 15.
Modern Types of Elevators.* F. E. Town. (20) Aug. 17.
Specifications for the Purchase of Fuel Oil: U. S. Bureau of Mines. (13) Aug. 17; (18) Aug. 5; (20) Aug. 3; (101) Sept. 1; (103) Aug. 19.
A Telferage System for Handling Baggage at an English Railway Station.* (13) Aug. 17.
Dynamometer Tests on Broad and Narrow Tired Wagons and on Plows. William Clyde Willard. (13) Aug. 17.
Hasleton Plant of the Republic Iron & Steel Company.* (20) Aug. 17.
Cupola Melting Practice. P. Munnoch. (Paper read before the Am. Foundrymen's Assoc.) (47) Aug. 18.
The Recovery of Benzol from Coke-Oven Gases.* D. C. Bagley. (22) Aug. 18.
Ditching with the Bowman Ditcher.* T. Ahern. (15) Aug. 18.
The Knight Valveless Engine.* F. G. Sterling. (46) Aug. 19; (13) Aug. 10.
Smoke Prevention in New York City. Ernest J. Lederle. (Paper read before the Internat. Assoc. for the Prevention of Smoke.) (62) Aug. 21.
Relation of Gas Producer to Smoke Problem. Robert H. Fernald. (Paper read before the Internat. Assoc. for the Prevention of Smoke.) (62) Aug. 21.
Four Years' Experience of Vertical Retorts at Cologne. F. Leisse. (66) Aug. 22.
Sampling and Analysis of Furnace Gas.* J. C. W. Fraser and E. J. Hoffman. (64) Aug. 22.
Machine Versus Hand Moulding. John Alexander. (Paper read before the Am. Foundrymen's Assoc.) (47) Aug. 25.
Coking Industry of South Yorkshire and Derbyshire. L. T. O'Shea. (Paper read before the Soc. of Chemical Industry.) (22) Aug. 25.

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*Illustrated.

Mechanical—(Continued).

The Steam Turbine.* (11) Serial beginning Aug. 25.

The Use of Petroleum as a Locomotive Fuel. Eugene Mcauliffe. (Abstract of paper read before the Internat. Ry. Fuel Assoc.) (47) Aug. 25.

Lubrication of Ball Bearings. Victor V. Page. (From *American Mcahinist.*) (47) Aug. 25.

Stress in Aeroplanes in Curvilinear and Fancy Flight.* A. F. Zahm. (46) Aug. 26.

Gasolene From Natural Gas. Frank H. Taylor. (Abstract from *Oil City Derrick.*) (62) Aug. 28.

Low Pressure Turbines as Coal Savers. (62) Aug. 28.

The Cost of Steam Power in Canada from Actual Performances. J. O. B. Latour. (Paper read before the Canadian Assoc. Steam E.) (96) Aug. 31.

Rates of the Queensborough Gas & Electric Co.; the First Commodity-Rate Case of the Public Service Commission for the First District of New York. (13) Aug. 31.

Recent Developments of the Suction Conveyor.* W. G. Hudson, M. Am. Soc. M. E. (13) Aug. 31.

Machine Molding.* Wilfred Lewis. (3) Sept.

The Design of a Double-Ended Marine Boiler.* John Gray. (94) Sept.

Tests on Warm Air Furnaces.* Frank L. Busey. (70) Sept.

Gas Engines; Their Design and Application. E. N. Percy. (95) Serial beginning Sept.

Tests of Warm Air Furnace Pipe.* A. W. Glessner. (70) Sept.

Mechanical Plant of the Madero Dock Granary, Buenos Aires.* (9) Sept.

A New High Pressure Gas Blower Set.* W. J. A. London. (83) Sept. 1; (64) Aug. 22.

The New Hinman Calorimeter.* (83) Sept. 1.

The Operation of Water Gas Generating Machines. R. A. Wallace. (Paper read before the Canadian Gas Assoc.) (83) Sept. 1; (24) Aug. 14.

Increasing the Efficiency of a Water-Gas Plant. John S. Haug. (Paper read before the Canadian Gas Assoc.) (83) Sept. 1.

Modern Developments in Oil Engine Practice. E. Shackleton. (Abstract of paper read before the Inst. of Mar. Engrs.) (47) Serial beginning Sept. 1.

An Aeroplane Factory and Its Work.* (12) Sept. 1.

16-Ton Steam Crane Navvy.* (12) Sept. 1.

Ore Loading Plant, Island of Elba.* C. A. Tupper. (16) Sept. 2.

The Gyrostatic Force of Rotary Engines.* Albert Kapteyn. (From *Flight.*) (19) Sept. 2.

Increasing Efficiency of Rotary Pumps.* C. A. Tupper. (64) Sept. 5.

Coke Oven Gas as an Open Hearth Fuel. Arthur P. Scott. (20) Sept. 7; (96) Aug. 31.

Small Open Hearth Furnaces. Walter Macgregor. (Paper read before the Am. Foundrymen's Assoc.) (20) Sept. 7.

Modern Mine Power Plant.* Guy C. Stoltz and Samuel Shapira. (16) Serial beginning Sept. 9.

Superheater Using Waste Heat.* (19) Sept. 9.

Récentes Applications du Moteur Diesel.* Ch. Dantin. (33) July 29.

Etude de la Transmission de la Chaleur entre un Fluide en Mouvement et une Surface Métallique. Leprince-Ringuet. (37) Serial beginning July 31.

Méthode pour l'Etude Expérimentale de l'Effet d'Amortissement des Empennages Horizontaux et des Surfaces Sustentatrices. G. de Bothezat. (37) July 31.

La Transmission de la Chaleur dans les Générateurs de Vapeur.* M. Emanaud. (33) Aug. 5.

L'Usine à Gaz du Landy (Seine) de la Société du Gaz de Paris.* R. Audra. (33) Serial beginning Aug. 12.

La Fabrication Industrielle des Charbons pour Lampes à Arc. Jean Escard. (33) Serial beginning Aug. 19.

Les Compteurs de Vapeur.* Eugène Grandmougin. (33) Aug. 19.

La Fabrication des Pneumatiques.* (33) Aug. 26.

Kammerlose Steilrohrkessel.* R. Ewald. (52) Serial beginning June 30.

Die Bedingungen gegen das Abheben des Seiles bei Drahtseilbahnen.* A. Fliegner. (107) July 22.

Der Guss einer Riesenschabotte.* O. Böhler. (50) July 27.

Steigerung der spezifischen Leistung von Viertakt-Gasmaschinen mit Druckluftspülung.* Wilhelm Hellmann. (48) Serial beginning July 29.

Die Riesenwerke der Indiana Steel Co. in Gary.* Fritz W. Lürmann. (50) Aug. 3.

Die neuere Entwicklung der ortfesten Oelmaschine.* A. Nagel. (48) Aug. 12.

Berechnung von Kolbenringen.* G. Barkhausen. (102) Aug. 15.

Dampfdurchgangsquerschnitte von Regelventilen.* P. Wagner. (48) Aug. 19.

Die Bestimmung der Dampffeuchtigkeit mit dem Drosselkalorimeter und die Anwendung desselben zur Prüfung von Wasserabscheidern.* Albert Sendtner. (48) Aug. 26.

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Metallurgical.

Electro-Plating Battery Plates.* J. D. Hubbard. (103) July 29.
International Smelter at Tooele, Utah.* Leroy A. Palmer. (45) Aug.
A Twentieth Century Cyanide Plant.* Charles E. Christensen. (45) Aug.
Magnetic Separation of Ores.* Lucius L. Wittich. (45) Aug.
Alloys. W. R. Whitney. (Paper read before the Am. Brass Founders Assoc.) (47) Aug. 4.
The Crystallisation of Cast Metals. Cecil H. Desch. (Paper read before the British Foundrymen's Assoc.) (47) Aug. 11.
Haselton Plant of the Republic Iron & Steel Company.* (20) Aug. 17.
Metallography as an Aid to the Ironfounder.* John S. G. Primrose. (Paper read before the British Foundrymen's Assoc.) (47) Aug. 18.
On the Selection and Use of Pyrometers. S. H. Stupokoff. (Paper read before the Am. Foundrymen's Assoc.) (47) Aug. 18.
A Blast-Furnace Gas Meter.* (22) Aug. 18.
Some Alloys for Permanent Magnets. C. F. Burgess and J. Aston. (Paper read before the Am. Electrochemical Soc.) (73) Aug. 18.
Trojan Cyanide Mill, Black Hills. Jesse Simmons. (16) Aug. 19.
Electric Steel Processes as Competitors of the Bessemer and Open Hearth. A. E. Greene. (Abstract of paper read before the Am. Electrochemical Soc.) (73) Aug. 25.
Manganese and Silicon in Foundry Practice. A. E. Outerbridge, Jr. (Paper read before the Am. Foundrymen's Assoc.) (19) Aug. 26.
The Elmore Flotation Process, The Specifications Showing the Original Claims for the Patents on Which the Process Is Based. (45) Sept.
The Counter-Current of Continuous Agitation, Decantation, and Dilution Applied to the Cyanide Process.* John E. Rothwell. (105) Sept.
Electric Tin Smelting. John Härdén. (105) Sept.
Electrolytic Production of Oxygen and Hydrogen and Welding and Cutting by the Oxyhydrogen Flame. (105) Sept.
New Method for the Rapid Determination of the Total Carbon in Iron, Steel and Ferro-Alloys.* A. L. Queneau. (105) Sept.
Refining of Silver and Gold Alloys.* Edward F. Kern. (105) Sept.
Efficiency Methods in Cupola Operation. John Jermain Porter. (9) Sept.
The Stock Process for Steel Castings.* (20) Sept. 7.
Alloys Used for Die-Castings. E. F. Lake. (20) Sept. 7.
Sur les Filiations d'Alliages Métalliques.* Le Gris. (93) Aug.
Progrès Récents dans le Grillage des Sulfures.* Léon Guillet. (93) Aug.

Military.

The Question of the Combination Projectile.* Hubner. (19) Aug. 5.
The Nitrogen Question from the Military Standpoint. Charles E. Munroe. (19) Aug. 19.
Logistics. William C. Bartlett. (19) Aug. 26.
Telegraph Battalions and Semi-Permanent Lines. C. de F. Chandler. (44) Sept.

Mining.

High-Tension Mining Switch-Gear.* F. Bernard Clark. (106) Vol. 41, Pt. 4.
A Flame-Test for the Estimation of Oxygen and Black-Damp in Naked-Light Mines. J. S. Haldane. (106) Vol. 41, Pt. 4.
Reversing the Ventilation. T. A. Southern and H. W. Halbaum. (57) Serial beginning July 28.
A New Face Conveyor.* T. Campbell Futers. (57) July 28.
The Cranberry Iron Ore Mine.* J. M. Cameron. (45) Aug.
Coal Mining in Arkansas, Method Used in Stripping Shallow Seams and in Mining Thin Seams With Partings.* A. A. Steel. (45) Aug.
New Uses of Explosives in Agriculture. F. H. Gunsolus. (3) Aug.
Electrical Equipment of the Sneyd Colliery, Burslem.* (57) Aug. 4; (22) Aug. 4.
Cave-Ins in Oil Wells.* Dorsey Hager. (103) Aug. 5.
Recent Developments in Diamond Mining.* C. A. Tupper. (103) Aug. 5.
Efficiency of Fine Grinding Machinery. Walter H. Urbiter. (16) Aug. 5.
The Sydvaranger Iron Mines.* Dwight E. Woodbridge. (16) Aug. 5.
Concrete Drop Shafts in Shifting Sands.* P. B. McDonald. (From *Min. and Eng. News.*) (96) Aug. 10.
The Economic Position of the Coal Industry of the United Kingdom. Allan Greenwell. (Abstract from paper read before the Inter. Soc. for the Promotion of Commercial Education.) (57) Serial beginning Aug. 11.
Ropeway Plant for the Powell Duffryn Coal Company, Ltd., Aberaman, near Aberdare.* (68) Aug. 12.
A Cone Friction for Mine Hoists.* (16) Aug. 12.
Compressed-Air Locomotives for Coal Mines.* C. B. Hodges. (Paper read before the West Virginia Coal Min. Inst.) (22) Aug. 18.

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Experiments on Liquid Mixtures for Laying Coaldust. W. M. Thornton. (Paper read before the North of England Inst. of Min. and Mech. Engrs.) (57) Serial beginning Aug. 11; (47) Aug. 18.
The Tin Deposits of Bolivia.* Miltiades Armas. (16) Serial beginning Aug. 19.
Buying Air-Compressors.* R. L. Webb. (103) Aug. 19.
Methods and Cost of Stripping with Steam Shovels in Utah.* L. A. Palmer. (Abstract from *Mining Magazine.*) (96) Aug. 24.
The Potter's Clay Industry of Cornwall.* Harold J. Shepstone. (19) Aug. 26.
The Saving of Fine Placer Gold.* Fred H. Hazard. (16) Aug. 26.
Witwatersrand Mining Costs.* E. M. Weston. (16) Serial beginning Aug. 26.
Mining Coal at Morgantown, W. Va.* R. B. Brinsmade. (16) Aug. 26.
The Cornwall, Pa., Magnetic Deposits.* (45) Sept.
The Coaldale Headhouse.* (45) Sept.
American Gem Mines and Mining.* John L. Cowan. (45) Sept.
Empire Mine and Mill, Grass Valley, Cal.* Al. H. Martin. (45) Sept.
Coal Boring at Calvert.* (22) Sept. 1.
Report on Rescue Apparatus. Committee Appointed by the South Midland Coalowners. (57) Serial beginning Sept. 1.
Shaw's Overwinder. T. Beach. (Paper read before the Midland Inst. of Min., Civ., and Mech. Engrs.) (57) Sept. 1.
Construction of the Summit Hill Fire Barrier.* Francis Donaldson. (14) Sept. 2.
The Ray Consolidated Copper Company.* Charles A. Dinsmore. (103) Sept. 2.
Operating Costs and Mine Management. Charles Janin. (103) Sept. 2.
The Cost of Mining in Nicaragua. Henry B. Kaeding. (16) Sept. 2.
Standard Electric Practice at Mines. (Abstract of Rules of Am. Min. Congress.) (16) Sept. 2.
Appraisal of Michigan Mines. J. R. Finlay. (16) Serial beginning Sept. 9.
Prospecting for Brown Iron Ore. H. S. Geismer. (16) Sept. 9.

Miscellaneous.

Address at the 43d Annual Convention, Chattanooga, Tennessee, June 13th, 1911. Mordecai T. Endicott, President, Am. Soc. C. E. (54) Vol. 73.
The Conservation of Fishery Resources.* Hugh M. Smith. (46) Aug. 12.
The Conservation of the Forests.* Gifford Pinchot. (46) Aug. 12.
Engineering Specifications. Frank F. Fowle. (42) Sept.
Pumping California Petroleum.* C. P. Bowie. (103) Sept. 2.
Methods and Cost of Clearing Logged-Off Land in the Pacific Northwest. Harry Thomson. (Abstract of Circular No. 25, Bureau of Plant Industry.) (86) Sept. 6.
Erddrucktheorie.* A. Hofmann. (81) Pt. 5.

Municipal.

Street Paving Crowns, Washington, D. C.* T. J. Powell, Assoc. M. Am. Soc. C. E. (54) Vol. 73.
Road Construction and Maintenance: An Informal Discussion Presented at the Meetings of January 20th and 21st, 1911. (54) Vol. 73.
Surface Tarring of Highways. Gugliebminetti. (104) July 28; (86) Aug. 16.
Construction, Maintenance and Repair of Highways. W. Astley Norris. (Paper read before the Institution of Mun. Engrs.) (104) July 28.
Street Curbs. Irving W. Stoddard. (67) Aug.
Some Fallacies of Sidewalk Construction. Jerome B. Landeld. (67) Aug.
Methods and Costs of Repairing Petrolithic Macadam, Oil Macadam and Surface Oiled Roads. W. A. Gillette. (86) Aug. 2.
Cost of Asphalt Pavement Repairs and Data on Life of Asphalt Pavement at Buffalo, N. Y. (86) Aug. 2.
Superelevation for Curves on Macadam Roads.* (13) Aug. 3.
Tests of Oil-Cement Concrete in Roads. (96) Aug. 3.
Standard Plans and Specifications for Paving, Seattle, Wash. (86) Aug. 9.
Methods of Constructing Roads Subject to Overflow and of Preventing Erosion of Roads and Ditches.* (86) Aug. 9.
Pneumatic Hammers for Tearing-Up Street Pavements.* Frank Richards, M. Am. Soc. M. E. (13) Aug. 10.
Brick Paving for Roads in Illinois and Ohio.* (13) Aug. 10.
Fire Protection in Towns. Reginald Brown, Assoc. M. Inst. C. E. (Paper read before the Institution of Mun. and County Engrs.) (104) Serial beginning Aug. 11.
Recommended Specifications for Bituminous Material (Roads). T. Warren Allen. (14) Aug. 12.
The Construction and Maintenance of Earth Roads in the South. W. S. Keller. (Paper read before the Good Roads Congress.) (96) Aug. 17.
A Prepared Filler for Macadam Roads.* Charles H. Hoyt. (13) Aug. 17.
Highway Improvement and Maintenance. H. P. Maybury, M. Inst. C. E. (Paper read before the Institution of Mun. and County Engrs.) (104) Aug. 18.

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Collection of Data for Standardisation of Road Construction and Maintenance. D. Ellison, Assoc. M. Inst. C. E. (Paper read before the Inst. of Mun. and County Engrs.) (104) Aug. 18.
The Dust Nuisance: Its Evils and Abatement. John S. Brodie, M. Inst. C. E. (Paper read before the Royal Sanitary Inst.) (104) Aug. 18.
Smoke Abatement in London and Hamburg. John B. C. Kershaw. (26) Aug. 18.
Calcium Chloride for Dust Prevention.* (104) Aug. 25.
Road Construction in San Diego County, California. (14) Aug. 26.
Service Test of Road Materials by the Road Board of Great Britain and a Description of Various English Proprietary Paving Materials. (86) Aug. 30.
Two Reports on Paving Materials and Work in Chicago. (13) Aug. 31.
Contracting Practice. DeWitt V. Moore, M. Am. Soc. Eng. Contrs. (60) Sept.
The Ohio State Experimental Road.* (60) Sept.
What is the Best Street Pavement? J. C. Travilla. (60) Sept.
Special Road Problems in Southern States. D. H Winslow. (Abstract of Circular, U. S. Office of Public Roads.) (14) Sept. 2.
Methods for Examination of Bituminous Road Materials. Prevost Hubbard and Charles S. Reeve. (Bulletin No. 38, Office of Public Roads, U. S. Dept. of Agriculture.) (62) Sept. 4.
An Economic Study of Snow Removal in Cities by Means of Melting Machines.* Nathan C. Johnson. (86) Sept. 6.
Der Bahnhofsvorplatz in Hannover.* Blum. (81) Pt. 5.

Railroads.

Mixed Traffic Engine, Soudan Government Railways.* (12) July 28.
Hot Water Supply for Railway Carriage Lavatories.* (21) Aug.
The Reconstruction of Clapham Junction Station, London, Brighton and South Coast Railway.* (21) Serial beginning Aug.
Lock-and-Block on the Victorian Government Railways.* (21) Aug.
Permanent Way of the Swiss Federal Railways.* (21) Aug.
Automatic Signals with Train Stops on High-Speed Inter-Urban Lines.* (21) Aug.
The New C. & N. W. Ry. Terminal at Chicago.* W. C. Armstrong. (87) Aug.
Installing Blind Stay-Bolts.* (Locomotives.) H. S. Jeffrey. (94) Aug.
A Proposed Modification in Railway Freight Yard Design.* (13) Aug. 3.
Railway Tests of Air-Brakes: 1878-1909. (13) Aug. 3; (96) Aug. 17.
Electrical Operation of the West Jersey & Seashore Railroad.* B. F. Wood. (42) Aug.
Locomotive Performance Under Different Degrees of Superheated Steam.* C. H. Benjamin and Louis E. Endsley. (Paper read before the Am. Master Mechanics' Assoc.) (47) Aug. 4.
Single-Phase Electric Locomotive for the Compagnie du Midi, of France.* (73) Aug. 4.
Petrol-Electric Railway Motor Car.* (12) Aug. 4.
Development of the Aurora, Elgin & Chicago Railroad.* (17) Serial beginning Aug. 5.
Four-cylinder Compound German Freight Locomotive.* (19) Aug. 5.
New Cars for Arkansas Valley Interurban Railway.* (17) Aug. 5.
Electrification of an English Railway.* (18) Aug. 5.
Tests to Determine the Necessary Depth of Stone Ballast.* (Abstract of Penn. R. R. Report.) (86) Aug. 9.
Making a 300 000 Cu. Yd. Railroad Embankment with Hydraulic Dredge.* George H. Bremner. (86) Aug. 9.
The Preservation of Trestle Stringers and Caps by Means of Housing.* Hunter McDonald, M. Am. Soc. C. E. (Abstract of paper read before the Eng. Assoc. of the South.) (96) Aug. 10.
Four-Cylinder Passenger Locomotive at the Turin Exhibition.* (11) Aug. 11.
The North Coast Railroad.* (15) Aug. 11.
Ductility in Rail Steel. P. H. Dudley. (Paper read before the Am. Soc. for Testing Materials.) (15) Aug. 11.
Steel Cars for the Newark Extension of the Hudson Tunnels.* (17) Aug. 12.
Gas Electric Car for San Francisco Railroad. (17) Aug. 12; (27) Aug. 12; (18) Aug. 26; (25) Sept.
Cross-Tie Records on the Sante Fé Railway System. (14) Aug. 12.
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The New Chicago Terminal Station of the Chicago & Northwestern Ry.* (13) Aug. 17.
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Detroit River Tunnel Yards.* (15) Aug. 18.
Removal of Excavated Material, Grand Central Terminal.* (14) Aug. 19.
The Canton-Hankow Railway.* (14) Aug. 19.
A Problem in Railway Location. L. B. Merriam. (14) Aug. 19.
Railway Terminal Power Plant.* (27) Aug. 19.

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Kerwin-Detroit Rail Grinder.* (17) Aug. 19.
Motor Cars for Tunnel and Suburban Service, Pennsylvania R. R.* (18) Aug. 19.
Japanese Railways. James F. Paige. (Abstract of paper read before the New England R. R. Club.) (47) Aug. 25.
The Peking-Kalgan Railway; China's Most Difficult Piece of Construction.* Lewis R. Freeman. (15) Aug. 25.
The Burlington Suction Dredge. (Railroad Construction.) (15) Aug. 25.
Train Resistance. W. F. Kiesel, Jr. (15) Aug. 25.
Mallet Locomotive with 20 Drivers, for the Santa Fé.* (15) Aug. 25.
The Electric Locomotives for the Lötschberg Tunnel.* (19) Aug. 26.
A 35-Ton Electric Locomotive for the Woodward Iron Works.* (18) Aug. 26.
The Car Shops of the Hudson & Manhattan Railroad in Jersey City, Structures Combining Structural Steel and Reinforced Concrete.* J. B. French. M. Am. Soc. C. E. (14) Aug. 26.
Northwestern Terminal in Chicago.* (27) Aug. 26.
Mikado Type Locomotives for the Illinois Central R. R.* (18) Aug. 26.
Electric Motor Cars for Tunnel Service.* (25) Sept.
Heavy Double-Ended Locomotives for Mexico.* (25) Sept.
Superheater Freight Locomotive 2-8-2 Type, Illinois Central Railroad.* (25) Sept.
Test of Simple 4-4-2 Type Locomotive on the Altoona Testing Plant, Pennsylvania Railroad.* (25) Sept.
0-8-8-0 Type Locomotive with Superheater, Delaware & Hudson Company. (25) Sept.
An Unusual Type of Flat Car.* (25) Sept.
Measurement of Steam Discharge in Locomotive Pop-Valves. (25) Sept.
Express Locomotives with Allfree Cylinder and Valves, Pittsburgh & Lake Erie R. R.* (25) Sept.
Novel Narrow Gauge Locomotive for an Indian Mountain Railway.* (25) Sept.
The Locomotive Boiler.* Robert H. Rogers. (From *Railroad Man's Magazine.*) (94) Sept.
The North-Eastern Railway Company's New Locomotive Boiler Shop.* (47) Sept. 1.
Corcovado Electric Railway.* (73) Sept. 1.
New Baltic Type Locomotive, Northern Railway of France.* (12) Sept. 1.
New Shops at Rockford, Ill.* (17) Sept. 2.
Electric Locomotive with Permutators in France.* (17) Sept. 2.
Proper Methods to be Observed in the Efficient Handling of the Electric Locomotive.*. (Abstract of paper read before the Traveling Engrs.' Assoc.) (18) Sept. 2.
Adequate Braking Power for Freight Cars.* John P. Kelly. (Abstract of paper read before the Air Brake Assoc.) (18) Sept. 2.
Value of Actual Demonstration as Compared with Oral Instruction in Air Brake Operation. (Paper read before the Traveling Engrs.' Assoc.) (18) Sept. 2.
Hospital Cars of the Swiss Federal Railways.* Alfred Gradenwitz. (46) Sept. 2.
Preliminary Surveys for the Puebla & Pacific R. R. of Mexico.* H. N. Roberts. (13) Sept. 7.
Station and Terminal Yards of Canadian, Northern and Grand Trunk Pacific at Winnipeg.* J. Schofield. (15) Sept. 8.
Practical Instruction in Fuel Economy. V. C. Randolph. (Paper read before the Traveling Engrs.' Assoc.) (15) Sept. 8; (18) Sept. 2.
Steelwork Erection at the New York Terminal of the Pennsylvania Railroad.* (14) Sept. 9.
A Reinforced Concrete Roundhouse for the New Haven Railroad.* (14) Sept. 9.
Chicago & Alton Locomotive Terminal at Bloomington.* (14) Sept. 9.
Locomotive du Type dit *Adriatic,* des Chemins de Fer de l'Etat autrichien.* M. Emanaud. (34) Aug.
Note sur les Travaux de Reconstruction de la Gare de Cambrai.* Piat et Wargniez. (38) Aug.
Elektrische 250 PS-Lokomotive der Valle-Maggia-Bahn. Georges Zindel. (107) July 15.
Die Schneeschleudermaschine der Berninabahn.* E. Gysel. (107) July 29.
Hebeböcke für Eisenbahnfahrzeuge. K. Kramár. (102) Aug. 1.
Die Eisenbahnhauptwerkstätte Saarbrücken-Burbach nach ihrer Erweiterung.* W. Schumacher. (102) Serial beginning Aug. 1.
Der elektrische Betrieb auf der Strecke Spiez-Frutigen der Berner Alpenbahn.* (107) Aug. 12.
Ueber die Absteckung des Lötschbergtunnels.* F. Baeschlin. (107) Serial beginning Aug. 26.

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Schöneberg-Berlin Underground Railway.* (17) Aug. 5.
Electric Railways in Buenos Aires.* (17) Aug. 5.
Method of Making Track Special Work Surveys.* Philip J. Kealy. (86) Aug. 9.

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Methods of Increasing the Efficiency of Surface Lines in Large Cities. Williston Fish. (Abstract from the *Annals* of the American Academy of Political and Social Science.) (96) Aug. 10.
The Buffalo Near-Side Single-Platform Car.* (73) Aug. 11.
Sprinkler System in Open Yard of Manhattan Elevated Railway.* (17) Aug. 12.
New Type of Storage-Battery Car.* (17) Aug. 19.
Newark Rapid Transit Car.* (19) Aug. 19.
Arnold Report on Providence Transportation Conditions.* (17) Aug. 19.
The New Paris Underground Railway.* (73) Aug. 25.
Faster Operation Versus Multiple-Unit Trains.* Clarence Renshaw. (Paper read before the Central Elec. Ry. Assoc.) (17) Aug. 26.
New Power Station of Worcester Consolidated Street Railway.* (17) Aug. 26.
Two New Rail Joints for Street Railway Track.* (13) Aug. 31.
The Efficiency of Sanded Tracks in Sidings for Car Retardation.* (From *Deutsche Strassen-und-Kleinbahn-Zeitung.*) (17) Sept. 2.
London's Electric Trains.* (19) Sept. 9.

Sanitation.

The Emscher Sewerage District and the Imhoff Tank.* Charles Saville. (Paper read before the Boston Soc. of Civil Engrs.) (1) July.
Specifications for and Cost of Concrete Sewer Pipe at Bellingham, Wash. H. A. Whitney. (67) Aug.
The Hudson Sewage Disposal System and the Disastrous Effects of Wool Waste.* Frank A. Barbour. (Paper read before the Boston Soc. of Civ. Engrs.) (1) Aug.
The Disposal of Manufacturing Waste.* R. S. Weston. (Paper read before the Boston Soc. of Civ. Engrs.) (1) Aug.
Reclamation of Tide Lands. J. O. Wright. (From *Bulletin,* U. S. Dept. of Agri.) (87) Serial beginning Aug.
Sewage Disposal with Respect to Offensive Odors. George W. Fuller, M. Am. Soc. C. E. (60) Serial beginning Aug.
Sewage Purification. S. Rideal. (Paper read before the Royal Sanitary Inst.) (104) Aug. 4.
The Dale Avenue Sewer in St. Louis.* (14) Aug. 5.
Design and Construction of the Baltimore Sewerage System.* Calvin W. Hendrick. (86) Aug. 9.
Hygienic Equipment for Modern Homes.* (101) Aug. 11.
The Discharge of Sewage Into Tidal Waters and Chemical Principles Involved. William Harpur and E. A. Letts. (Papers read before the Royal San. Inst.) (104) Serial beginning Aug. 11.
The Operation of the Milwaukee Incinerator. (14) Aug. 12; (13) Sept. 7.
Reclamation of River Bottom Lands.* John J. Harman. (Paper read before the Iowa Drainage Assoc.) (76) Aug. 15.
Drainage in Eastern England: Comparison of English and American Drainage Methods, Giving Results of Observations Made by C. G. Elliott.* (76) Aug. 15.
Proposed Basis for Rating House-Heating Boilers and Furnaces.* Frank L. Busey. (Abstract of paper read before the Am. Soc. of Heating and Ventilating Engrs.) (64) Aug. 15.
Laying of Drain Tile.* A. F. Greaves-Walker. (Paper read before the Northwestern Drain Tile Assoc.) (76) Aug. 15.
Standards for Rating and Installing Furnaces. (Paper read before the Nat. Assoc. of Sheet Metal Contractors.) (101) Aug. 18.
The Flushing System for the Gowanus Canal, Brooklyn.* (14) Aug. 19.
Sewage Purification at the Montmesly Works, Paris.* (14) Aug. 19.
Methods and Costs of Tunnel and Open Cut Excavation in Sandstone for a Sewer at Pratt City, Alabama.* (86) Aug. 23.
Proposed Intercepting Sewers and Sewage Disposal in New Bedford, Mass.—A Study in Design.* (86) Aug. 23.
Comparative Costs of Sewage Purification. (96) Aug. 24.
A Large Fan and Air Conditioning System for a Cotton Mill.* L. L. Lewis. (13) Aug. 24.
The Laying and Testing of Earthenware Sewers and Drains.* A Sayers. (Abstract of paper read before the Royal San. Inst. Congress.) (104) Aug. 25.
Heating by Exhaust Steam. George G. Bennett. (From *Southern Engineer.*) (47) Aug. 25.
Experimental Sewage Purification at Worcester.* (14) Aug. 26.
The Significance of Flora and Fauna in Maintaining the Purity of Natural Waters and How They Are Affected by Domestic Sewage and Industrial Wastes. Emil Kuichling, M. Am. Soc. C. E. (Tr. from German article by Maximilian Marsson.) (13) Aug. 31.
Notable Tunnel Ventilating Plant.* (20) Aug. 31.
Heating and Ventilating High School Buildings at Decatur, Ill.* Samuel R. Lewis. (70) Sept.
Steam Heating in an Exposed Club House.* (101) Sept. 1.

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The Proposed Disinfection of Sewage at New Bedford. (14) Sept. 2.
Methods and Cost of Vitrified Clay Conduit Construction in Salt Lake City. R. E. Froiseth. (86) Sept. 6.
Design of Sewers and Sewage Purification Plant for La Grange, Illinois.* Frank L. Stone. (86) Sept. 6.
A Temporary Screening Plant at Flushing.* (14) Sept. 9.

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SOME OF THE PROPERTIES OF OIL-MIXED PORTLAND CEMENT MORTAR AND CONCRETE.

By Logan Waller Page, M. Am. Soc. C. E.

To be Presented November 1st, 1911.

In October, 1909, the writer found that oil in considerable quantities could be combined with wet Portland cement paste by a simple mixing process. It was noted that when oil was added to wet cement it disappeared completely when mixed for a few moments. and, furthermore, that there was no apparent separation of the ingredients upon setting. Experiments were at once begun with various kinds of oil, to ascertain which was best adapted for the mixture. After these preliminary enquiries were completed, the following tests were conducted, or are now in progress, in order to investigate the properties of oil-mixed cement, mortar, and concrete:

(1) The tensile strength of neat cement and 1:3 mortar;
(2) The time of setting;
(3) The crushing strength of mortar and concrete;
(4) Impact tests on concrete;
(5) The modulus of elasticity of concrete;
(6) The absorption of concrete;
(7) The permeability of concrete;
(8) Bond tests;
(9) The density of concrete.

Note.—These papers are issued before the date set for presentation and discussion. Correspondence is invited from those who cannot be present at the meeting, and may be sent by mail to the Secretary. Discussion, either oral or written, will be published in a subsequent number of *Proceedings*, and, when finally closed, the papers, with discussion in full, will be published in *Transactions*.

Some of these tests are in an incomplete state; others are contemplated, in an effort to develop those phases of the material which give most promise of practical results. The writer's excuse for publishing them in such an incomplete state is that, with his limited facilities for testing, it would require considerable time to complete the work, and, in view of the results already obtained, it seemed likely that engineers with better facilities would hasten the work through its experimental stage.

Materials.—The materials used consisted of Portland cement, river sand, and ¾-in., crusher-run gneiss. Analyses of the several oils selected for use are given in Table 1. The cement complied with the specifications recommended by the Special Committee on Concrete and Reinforced Concrete. Mechanical analyses, typical of the sand and stone used, are given in Table 2.

The sand contained 37% of voids, the stone 43 per cent.

Method of Mixing Concrete.—The weights per cubic foot of the dry sand and stone were determined, the materials being loosely shaken in a measure containing 1 cu. ft. The weight of cement was assumed to be 95 lb. per cu. ft. The percentage of moisture in the sand and stone was determined every day that a concrete mixture was made, and the proportions of sand and stone in the mixture were corrected for the moisture content. All concrete was proportioned by volume, but the materials were measured by weight. In all cases the percentage of oil used is based on the weight of the cement in the mixture.

The following method of mixing was used: The proper quantities of cement and sand were mixed dry until of uniform color. Water was then added and the mass was turned as often as was necessary to produce a rather wet mortar. The water added to the mortar was not weighed, the appearance of the mix being the criterion for determining the proper quantity. In general, however, the total quantity of water, including that in the sand, was about 17% of the total weight of the cement and sand. After having mixed the mortar, the desired quantity of oil was added, and the mass was turned over as many times as was necessary to break up the oil and incorporate it thoroughly with the other ingredients. The previously moistened stone and the oil-cement mortar were then combined and turned until thoroughly mixed. The percentage of water required to make a rather soft mixture was determined from the appearance of the

TABLE 1.—ANALYSIS OF OILS USED

Sample number	4 145	4 146	4 147
Type	Fluid Residual Oil.	Fluid Residual Oil.	Fluid Residual Oil.
Character	Fluid, greasy.	Fluid, greasy.	Fluid, greasy.
Specific gravity at 25°/25° cent	0.924	0.910	0.926
Loss at 163° cent., 5 hours, 20 grammes	6.86%	12.56%	7.98%
Character of residue	Fluid, greasy.	Fluid, greasy.	Fluid, greasy.
Soluble in CS_2, air temperature	99.99%	99.99%	99.93%
Organic matter insoluble	0.01	0.01	0.07
Inorganic matter insoluble	0.00	0.00	0.00
	100.00	100.00	100.00
Percentage of total bitumen insoluble in 86° paraffin naphtha	2.23%	6.82%	10.16%
Fixed carbon	2.41	3.36	5.11
Specific viscosity, Engler 50° cent	14.2	6.4	18.2

first batch, and every batch of the same proportions made thereafter contained the same gross quantity of water.

All mortar compression test pieces were proportioned by weight, the sand being thoroughly dry; 19.5% of water was used in the mix.

TABLE 2.—MECHANICAL ANALYSES OF SAND AND STONE.

SAND.		STONE.	
Sieve.	Percentage retained.	Sieve.	Percentage retained.
¼-in	3	¾-in	28.4
⅛-in	11	½-in	66.3
No. 10	17	¼-in	92.1
No. 20	42	⅛-in	98.4
No. 30	66		
No. 40	87		
No. 50	93		
No. 80	96		
No. 100	99		

1:3 Mortar.—Tests made on 1:3 mortar containing oil show that the tensile strength is influenced very little by the oils at 7 days, 28 days, or 6 months, and furthermore, there is a decided gain in strength at 28 days and 6 months over that at 7 days. The strength of oil-mixed mortars is given in Table 3, and plotted on Fig. 1.

in Cement-Concrete Mixtures.

4 149	4 170	4 923	4 981	5 053
Fluid Residual Oil.	Cut-back Oil Asphalt.	Fluid Residual Oil.	Fluid Residual Oil.	Fluid Residual Oil.
Fluid, greasy.	Fluid, sticky.	Fluid, greasy.	Fluid, slightly sticky.	Fluid, slightly sticky.
0.923	....	0.945	0.893	0.924
7.02%	18.38%	1.35%	27.17%	3.70%
Fluid, greasy.	Semi-solid, sticky.	Fluid, greasy.	Slightly granular; more viscous than original.	Fluid; granular in appearance.
99.95%	99.81%	99.96%	99.95%	99.90%
0.05	0.13	0.04	0.02	0.07
0.00	0.06	0.00	0.03	0.03
100.00	100.00	100.00	100.00	100.00
2.24%	16.87%	3.46%	1.00%	4.12%
1.98	....	4.18	1.77	2.82
20.2	....	65.1	2.5	17.4

TABLE 3.—Tensile Strength of 1:3 Mortar, Ottawa Sand.

Percentage of oil.	Oil No. 4 923.			Oil No. 5 053.		Oil No. 4 981.	
	7 days.	28 days.	6 mos.	7 days.	28 days.	7 days.	28 days.
0	256	296	326	244	331	283	367
2½	299	400	449	297	353	259	327
5	287	316	372	313	334	268	341
10	252	331	360	304	371	264	329

Time of Setting.—The addition of oil retards both the initial and final set. Quantitative results of tests with the Gillmore needles on specimens subjected to identical conditions are given in Table 4 and are shown graphically on Fig. 2. The effect of 10% of oil is to increase the time of initial set about 90%, and the time of final set about 60 per cent.

TABLE 4.—The Effect of Oil on the Time of Setting of Portland Cement.

Oil No. 4 923.

Percentage of oil............	0	2½	5	10
Initial set.....................	1 h. 18 m.	1 h. 31 m.	1 h. 57 m.	2 h. 27 m.
Final set.......................	3 h. 43 m.	4 h. 56 m.	5 h. 27 m.	5 h. 57 m.

Crushing Strength.—Specimens of mortar and concrete were moulded in cylindrical forms, 6 in. in diameter and 6 in. high. The materials were deposited in the moulds in layers about 2 in. thick, and were troweled and tamped. The moulds were removed after one day, but the specimens were not disturbed until the second day after moulding. Air-cured specimens were kept moistened for 7 days after moulding. All tests were made in a universal machine having a capacity of 200 000 lb. The bearing surfaces of all mortar specimens were bedded in several thicknesses of blotting paper. It was found necessary to bed the top surface of each concrete specimen in plaster of Paris before testing, blotting paper being used in addition to this

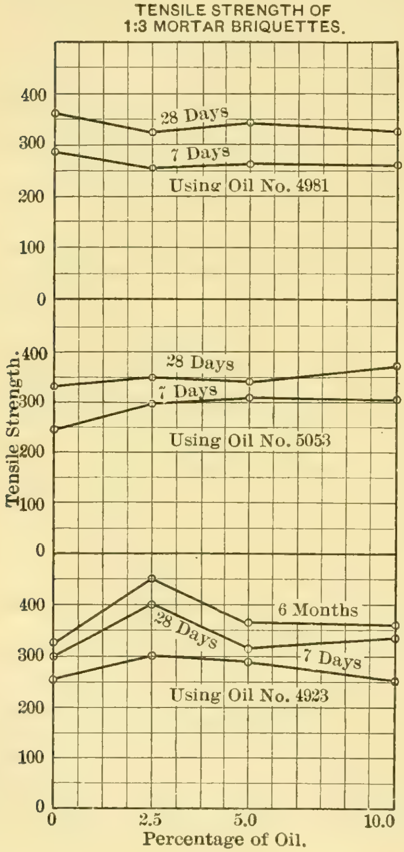

FIG. 1.

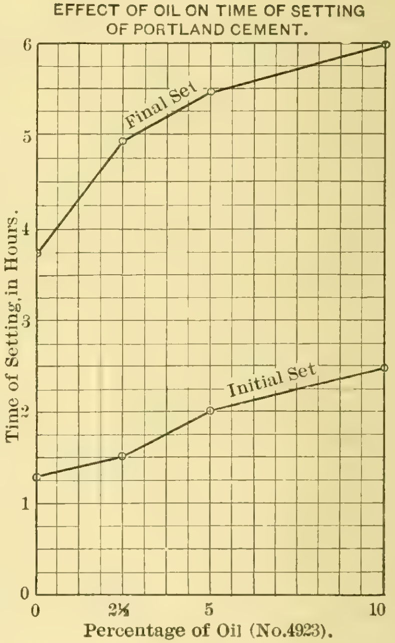

FIG. 2.

bedding. The specimens were crushed at a speed of 0.152 in. per min., and the crushing load was taken at the drop of the scale beam.

The numerical results of the crushing tests are given in Table 5, and are plotted on Figs. 3 and 4. As would be expected with an inert substance like oil, the crushing strength decreases in general with increasing quantities of oil. In the case of the oil-mixed mortars, in only one instance is there a serious decrease of strength with the addition of oil up to 10%, namely, that in which oil No. 4 145 was used. At 28 days water-cured mortar specimens containing 10% of oil are at least 80% as strong as the plain mortar specimens. In every instance there is a substantial gain in strength at 6 months over that at 28 days; this is equally true of the one-year specimens. Specimens cured in air are somewhat erratic in behavior. In some instances a considerable gain in strength occurs, in others, a noticeable decrease.

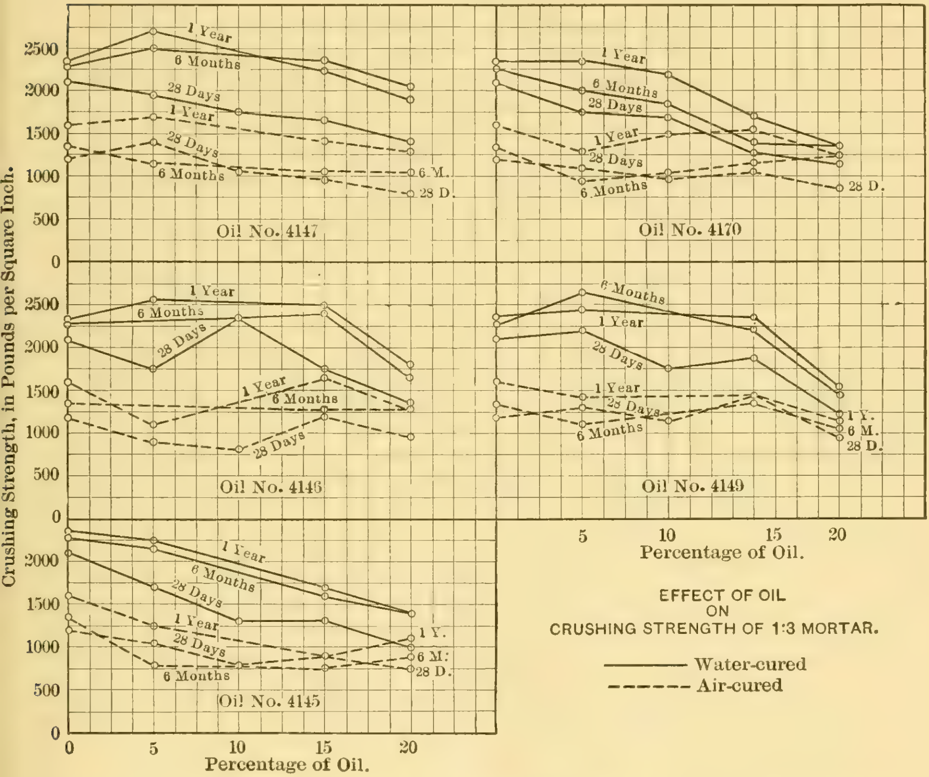

FIG. 3.

TABLE 5.—TESTS OF OIL-MORTAR AND OIL-CONCRETE CYLINDERS.

Crushing Strength, in pounds per square inch.

All 1 : 3 mortar (by weight) except specimens 6c to 18c.

Specimens 6c to 12c are of 1 : 3 : 6 Concrete; Specimens 13c to 18c are of 1 : 3 : 5 Concrete (by volume).

The numbers in parentheses indicate the number of specimens tested.

Mark.	Percentage of oil.	Character of oil.	STORED IN AIR.			STORED IN WATER.		
			28 days.	6 months.	1 year.	28 days.	6 months.	1 year.
No.								
1	0	....	1 170 (5)	1 350 (2)	1 597 (2)	2 135 (6)	2 275 (2)	2 308 (2)
17	5	Fluid Residual Oil No. 4 145	1 050 (2)	830 (2)	1 220 (2)	1 715 (2)	2 160 (2)	2 240 (2)
2	10	" " " " "	790 (1)	....	....	1 320 (1)	....	....
22	15	" " " " "	895 (2)	780 (2)	880 (2)	1 290 (2)	1 615 (2)	1 700 (2)
27	20	" " " " "	775 (2)	910 (2)	1 125 (2)	1 020 (2)	1 420 (2)	1 425 (2)
18	5	Fluid Residual Oil No. 4 146	915 (2)	....	1 110 (2)	1 770 (2)	....	2 560 (2)
3	10	" " " " "	830 (1)	....	....	2 400 (2)	....	....
23	15	" " " " "	1 215 (2)	1 275 (2)	1 670 (2)	1 775 (2)	2 410 (2)	2 475 (2)
28	20	" " " " "	935 (2)	1 295 (2)	1 380 (2)	1 345 (2)	1 640 (2)	1 780 (2)
19	5	Fluid Residual Oil No. 4 147	1 405 (2)	1 155 (2)	1 715 (2)	1 995 (2)	2 475 (2)	2 700 (2)
4	10	" " " " "	1 070 (1)	....	....	1 720 (1)	....	....
24	15	" " " " "	975 (2)	1 085 (2)	1 435 (1)	1 670 (2)	2 350 (2)	2 250 (1)
29	20	" " " " "	795 (2)	1 055 (2)	1 310 (2)	1 400 (2)	2 010 (2)	1 895 (2)
21	5	Fluid Residual Oil No. 4 149	1 305 (2)	1 105 (2)	1 395 (2)	2 220 (2)	2 655 (2)	2 450 (1)
6	10	" " " " "	1 170 (1)	....	....	1 750 (1)	....	....
26	15	" " " " "	1 440 (2)	1 395 (2)	1 330 (2)	1 895 (2)	2 215 (2)	2 320 (2)
31	20	" " " " "	925 (2)	1 085 (2)	1 135 (2)	1 230 (2)	1 475 (2)	1 530 (2)
7	5	Cut-back Oil Asphalt No. 4 170	1 010 (2)	940 (2)	1 315 (2)	1 760 (2)	2 065 (2)	2 345 (1)
8	10	" " " " "	980 (2)	1 005 (2)	1 510 (2)	1 680 (2)	1 825 (2)	2 200 (1)
9	15	" " " " "	1 055 (2)	1 170 (2)	1 555 (2)	1 265 (2)	1 365 (2)	1 685 (1)
10	20	" " " " "	890 (2)	1 220 (2)	1 325 (2)	1 175 (2)	1 340 (2)	1 375 (1)
6c	0	....	1 020 (3)	....	....	1 370 (2)	....	....
7c	2½	Fluid Residual Oil No. 4 923	750 (2)	....	....	1 253 (3)	....	....
8c	5	" " " " "	711 (2)	....	....	1 142 (2)	....	....
9c	10	" " " " "	656 (2)	....	....	961 (3)	....	....
10c	15	" " " " "	542 (2)	....	....	750 (2)	....	....
12c	25	" " " " "	605 (3)	....	....	620 (3)	....	....
13c	0	....	920 (2)	....	....	1 342 (3)	....	....
14c	2½	Fluid Residual Oil No. 4 923	787 (2)	....	....	1 250 (2)	....	....
15c	5	" " " " "	720 (2)	....	....	1 082 (2)	....	....
16c	10	" " " " "	698 (2)	....	....	1 040 (2)	....	....
17c	15	" " " " "	693 (2)	....	....	1 040 (2)	....	....
18c	20	" " " " "	572 (2)	....	....	904 (2)	....	....

Concrete, like mortar, when mixed with oil, shows a decrease in strength, that containing 10% of oil having roughly 75% of the strength of plain concrete when stored in water. Air-cured concrete, mixed in proportions of 1 : 3 : 6 and 1 : 3 : 5, containing 10% of oil, has 65 and 75%, respectively, of the strength of the plain concrete mixtures. At the completion of the one-year tests on compression, a marked increase in strength is shown over similar tests at 6 months. The next tests will be made at the expiration of two years.

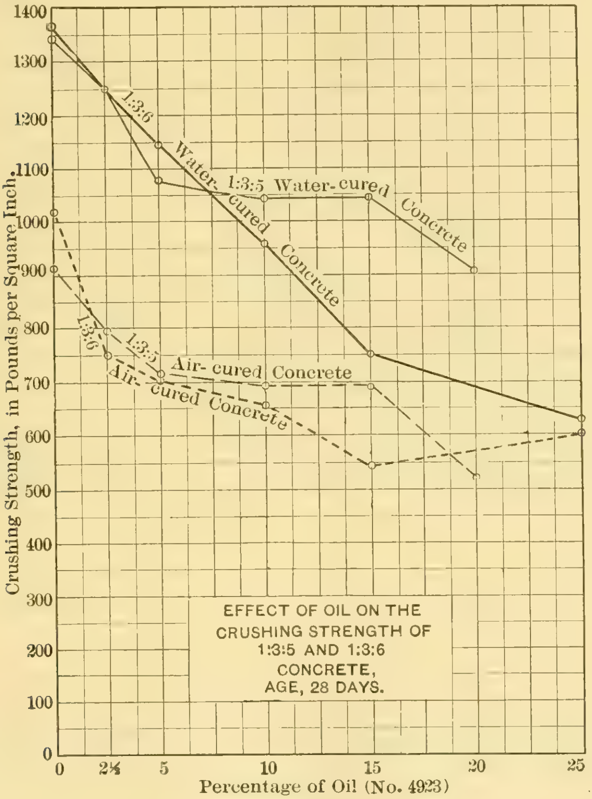

FIG. 4.

Toughness.—Cylinders of concrete, 6 in. in diameter and 6 in. high, were tested in the Page impact machine under the blows of a 10-kg. hammer, falling upon a 5-kg. plunger from successively increasing heights of 1 cm. The height of the last blow, causing rupture, corresponds to the number of blows. The end of the plunger in contact with the test pieces is spherical in shape, with a radius of 3 cm. The specimens were set in plaster of Paris on a piece of plate glass, and after the plaster had hardened they were mounted in the impact machine, the bedded end on the anvil. Fig. 1, Plate CXXVIII, is a view of the impact machine, and the specimen after failure. The results of this test indicate that the toughness or resistance to impact of oil-mixed concrete differs but slightly from that of plain concrete. The impact tests were made on only one specimen from each mix. Failure was indicated by the development of radial cracks, of which there were sometimes two and as often three. The numerical results of the impact tests are given in Table 6.

TABLE 6.—NUMBER OF BLOWS REQUIRED TO PRODUCE FAILURE.

Percentage of oil, No. 4 923.	1:3:5 CONCRETE.		1:3:6 CONCRETE.	
	Air-cured.	Water-cured.	Air-cured.	Water-cured.
0	18	15	15	21
2½	15	33	14	18
5	23	20	15	20
10	13	20	12	21
15	14	20	13	16
20	10	22	..	..
25	..	..	15	16

Modulus of Elasticity.—Tests for the modulus of elasticity were made on specimens of the usual size, 8 in. in diameter and 16 in. high. The deformations were measured with a double micrometer compressometer,* shown in Fig. 2, Plate CXXVIII. The specimens were carefully bedded in plaster of Paris, a spherical bearing block being interposed between the top of the specimen and the moving head of the machine. Loads were applied in 2 500-lb. and 5 000-lb. increments, and were released to the initial load of 500 lb. after each increment of 5 000 lb., thus permitting of the determination of the amount of permanent set.

Typical stress-deformation and permanent-set curves are shown in Figs. 5 and 6. The values of the initial modulus of elasticity are given in Table 7.

---

* This instrument is described by J. M. Porter, Assoc. M. Am. Soc. C. E., in *Proceedings*, Am. Soc. for Testing Materials, Vol. X, 1910.

PLATE CXXVIII.
PAPERS, AM. SOC. C. E.
SEPTEMBER, 1911.
PAGE ON
OIL-MIXED PORTLAND CEMENT,
MORTAR AND CONCRETE.

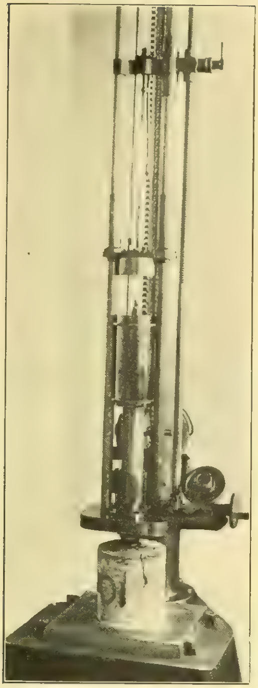

FIG. 1.—TOUGHNESS TEST.

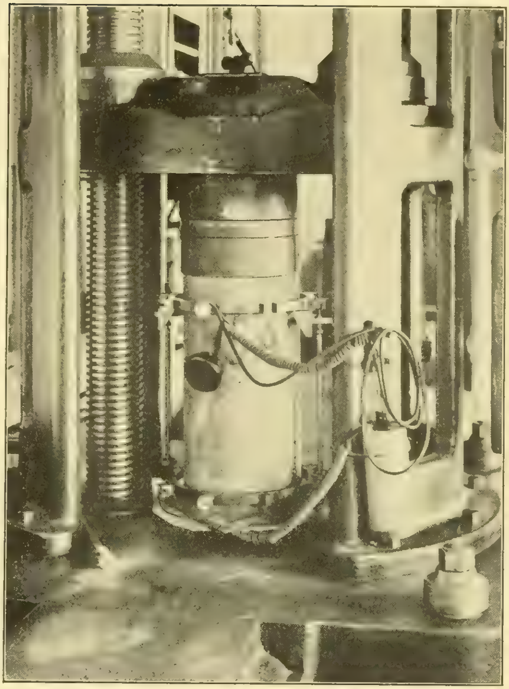

FIG. 2.—TEST FOR MODULUS OF ELASTICITY.

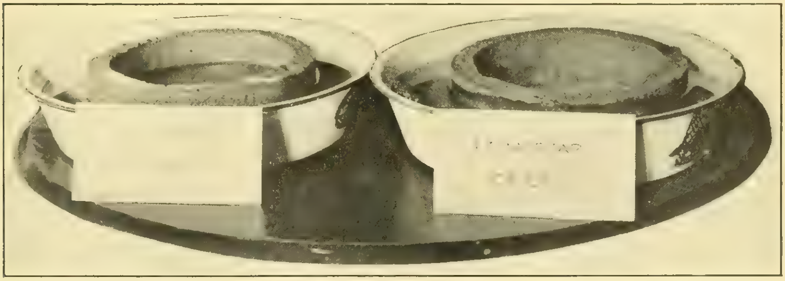

FIG. 3.—ABSORPTION TEST.

TABLE 7.—INITIAL MODULUS OF ELASTICITY—AGE, 28 DAYS.

Percentage of oil, No. 4 923.	1:3:5 CONCRETE.		1:3:6 CONCRETE.	
	Air-cured.	Water-cured.	Air-cured.	Water-cured.
0	1 300 000	2 550 000	1 300 000	2 200 000
2½	1 350 000	2 700 000	1 000 000	2 400 000
5	1 250 000	2 350 000	850 000	1 900 000
10	1 700 000	3 950 000	1 150 000	1 900 000
15	1 300 000	2 500 000	730 000	2 050 000
20	1 400 000	3 000 000	....	....
25	....	....	1 400 000	1 950 000

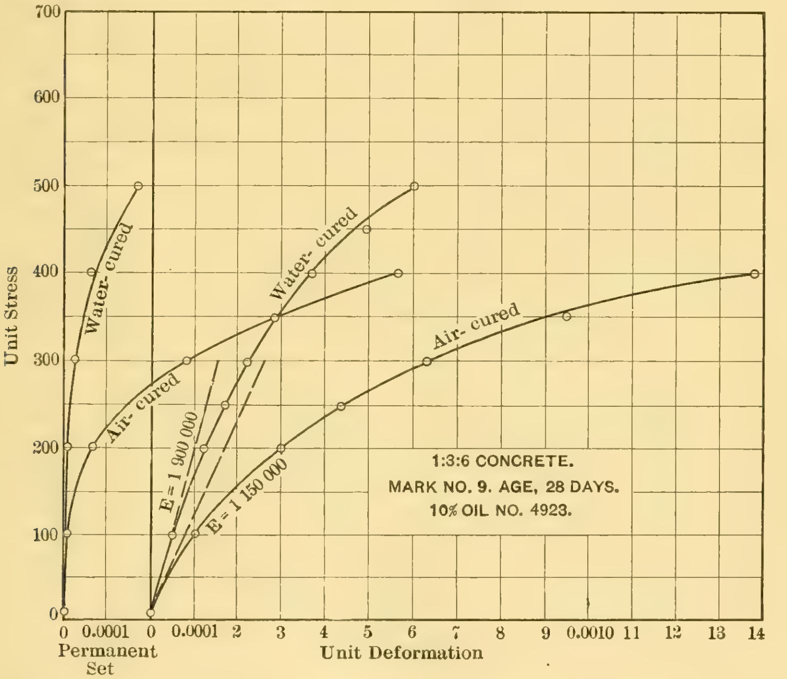

FIG. 5.

The results in Table 7 indicate that the addition of oil to concrete has very little effect on its stiffness, the initial modulus of elasticity, with a few exceptions, showing but little change. The effect of storing in water is to increase the modulus of elasticity to more than that of air-cured specimens, and is as true with oil as without it.

Permanent Set.—In the endeavor to discover the effect of oil on the elasticity of concrete, micrometer readings of permanent set were taken after releasing the load to its initial value of 500 lb. In 1 : 3 : 5 concrete, containing as much as 10% of oil, the permanent deformation existing after the application of 500 lb. per sq. in. was less than that in the specimen containing no oil. This was true of both air-cured and water-cured specimens. The elasticity of 1 : 3 : 6 concrete appears to suffer with the addition of oil, the permanent set of the 10% oil mixture, air-cured, being 0.00076 in. per inch of length, as against 0.00019 in. for the plain concrete specimens. The corresponding ratio appears to exist for the water-cured specimens. The permanent set of the 10% oil mixture was 0.00017 in. after the application of 500 lb. per sq. in. Here, again, the beneficial effect of storing in water is well marked, the permanent set being very small for water-cured concrete, when compared with that cured in air.

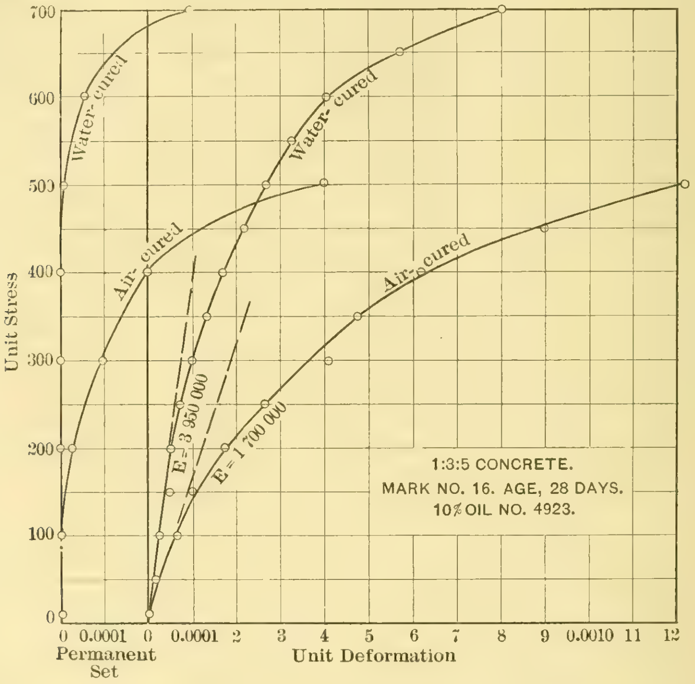

FIG. 6.

Absorption.—In order to determine the water-proofing qualities of oil-mixed concrete, compared with those of a plain mixture, absorption tests were made on 1 : 3 : 6 concrete cylinders, 6 in. in diameter and

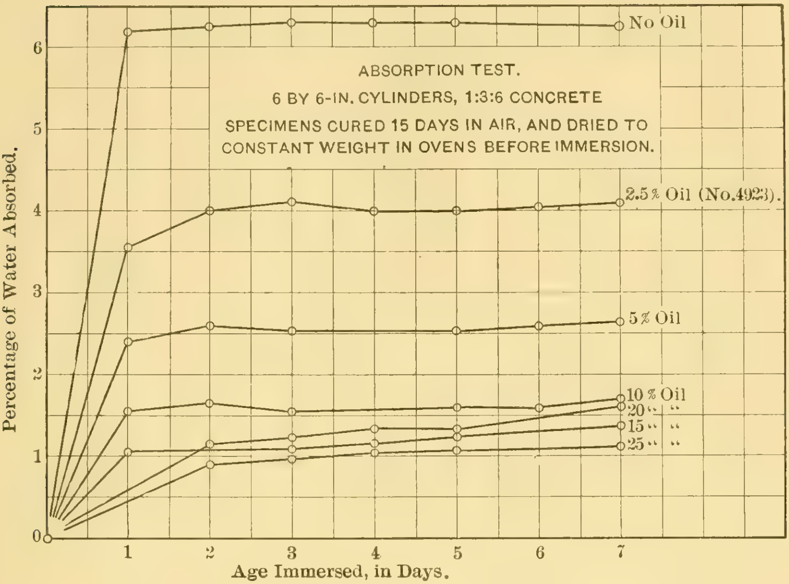
ABSORPTION TEST.
6 BY 6-IN. CYLINDERS, 1:3:6 CONCRETE
SPECIMENS CURED 15 DAYS IN AIR, AND DRIED TO CONSTANT WEIGHT IN OVENS BEFORE IMMERSION.
Percentage of Water Absorbed.
Age Immersed, in Days.
0
1
2
3
4
5
6
7
No Oil
2.5% Oil (No.4923).
5% Oil
10% Oil
20 " "
15 " "
25 " "

FIG. 7.

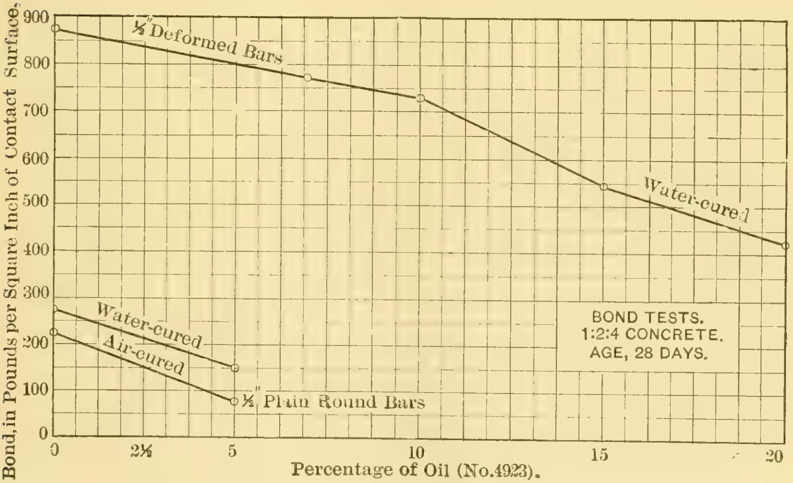
BOND TESTS.
1:2:4 CONCRETE.
AGE, 28 DAYS.
Bond, in Pounds per Square Inch of Contact Surface.
Percentage of Oil (No.4923).
0
100
200
300
400
500
600
700
800
900
2½
5
10
15
20
½" Deformed Bars
Water-cured
Water-cured
Air-cured
½" Plain Round Bars

FIG. 8.

6 in. high. The cylinders were dried to constant weight in an oven, after being cured for 15 days in air. They were then completely immersed in water, and were weighed every day until they had attained constant weight. The results of these tests are plotted on Fig. 7. It will be noted that the addition of oil decreases greatly the percentage of absorption, the cylinder containing 10% of oil absorbing but 1.7% of water, based on the dry weight, while 6.25% was absorbed by the cylinder containing no oil. In almost every case the maximum absorption was attained within one day after immersion, and, furthermore, the rate of absorption seemed to be inversely dependent on the quantity of oil added. It will be noted that there is approximately only 0.5% difference between the absorption of the cylinders containing, respectively, 10 and 25% of oil. The inference to be drawn from this fact is that 10% of oil is nearly as effective as 25%, as far as water-proofing is concerned.

Four vessels of 1:3 mortar, each 2½ in. high, about ½ in. thick, and having an outside diameter of 8 in., after hardening in moist air for one week, were immersed in water to a depth of 5 cm. Vessel No. 1 was made with no admixture of oil. A damp spot appeared inside about 1 min. after immersion. In one hour it was completely water-soaked, the moisture having climbed by capillarity above the level of the surrounding water. Within a few days after immersion. water had penetrated the plain mortar vessel until its level inside was the same as that outside. Vessels Nos. 1 and 3 are shown on Fig. 3, Plate CXXVIII. Vessels Nos. 2, 3, and 4 contained, respectively, 5, 10, and 20% of oil. After an immersion of 6 months, the interiors of the oil-mixed vessels are as dry as they were on the day they were placed in the water. A corresponding series of tests was made on mortar vessels, made to contain water, with like results. The plain mortar vessel leaked, and those of oil-mixed mortar were perfectly tight. These results show with certainty the water-proofing qualities of oil-mixed mortar and concrete.

Permeability.—The following tests were made on specimens of 1:3 mortar, 3 in. thick and 6 in. in diameter: Plain 1:3 mortar, at the age of 28 days, under a pressure of 30 lb. showed dampness in about ½ hour. Under a pressure of 40 lb., applied for 24 hours, the leakage amounted to 146 cu. cm. Specimens of the same mixture, but containing 5 and 10% of oil No. 4 923, remained perfectly dry for 24 hours, under a pressure of 40 lb.

A ½-in. coat of 1 : 3 mortar, containing 10% of oil No. 4 923, applied to the surface of a very porous concrete, was absolutely effective in preventing all leakage, even under comparatively high pressure.

Bond Tests.—Tests were made to determine the relative strength in bond of oil-mixed and plain concrete. Specimens were made of 1 : 2 : 4 concrete, mixed with 23½% of water, based on the weight of cement and dry sand, making a rather wet mix. Rods 12 in. long were embedded in the center of cylinders 8 in. in diameter and 8 in. long, one end projecting about ½ in. through the bottom. The specimens were bedded in plaster of Paris on a cast-iron plate mounted on a spherical bearing block. The test consisted in pushing the rods through the concrete, the point of failure being taken at the drop of the scale beam.

Two kinds of bars were used, plain and deformed. All specimens were tested at 28 days, and the results are plotted on Fig. 8. The points plotted represent the average of two tests, which in all cases ran very closely together. The results show that the effect of oil is to decrease the bond strength, the decrease depending on the quantity of oil added. It is evident that the bond between plain bars and concrete is affected so seriously by the admixture of oil that it would be extremely inadvisable to use such a combination. The bond of deformed bars is not affected so seriously. With an admixture of 10% of oil, which is as much as is necessary to use, the bond strength is 84% of that attained by the mixture containing no oil.

Service Tests.—During April and May, 1910, two bridge surfaces of oil-concrete were laid at Ridgewood, N. J. In the Borough of Richmond, New York City, during May and June, 1910, about 400 ft. of street surface was laid with different aggregates. About 300 ft. of street in Washington, D. C., was surfaced in June, 1910. Numerous inspections of this work have been made, and, up to the present time, it is all in very good condition. About ½ mile of roadway, laid with 10% oil-concrete in the suburbs of Harrisburg, Pa., in the summer of 1910, is also reported to be in very good condition. A vault, 112 ft. long and 18 ft. wide, in the United States Treasury Department, was built in the autumn of 1910. The side-walls of this vault contain 10% of oil. Its roof was constructed of ordinary reinforced concrete with about 3 in. of 10% oil-concrete on top. For several months this roof was subjected to a head of water of several feet without showing any signs of leakage. Another vault, in the north end of the Treasury, on account of leakage, has never been available for storing anything of value. Its roof was treated with oil-concrete, and is now perfectly dry. Numerous floors in the sub-basement of the Treasury Department, and a floor in the Office of Public Roads, have been constructed with 10% oil-concrete, and have remained absolutely free from dampness. A tank, about 12 ft. long, 4 ft. wide, and 4½ ft. high, constructed in the Office of Public Roads during the winter of 1910, has been continually full of water, and has not shown the slightest signs of leakage.

Summary of Conclusions.—The following tentative conclusions as to the effect of the oils used in cement and concrete may be drawn from the foregoing investigations:

1. The tensile strength of 1:3 oil-mixed mortar differs very little from that of plain mortar, and shows a substantial gain in strength at 28 days and 6 months over that at 7 days.

2. The times of initial and final set are delayed by the addition of oil, 10% of oil increasing the time of initial set by 90%, and the time of final set by 60 per cent.

3. The crushing strength of mortar and concrete is decreased by the addition of oil to the mix, concrete with 10% of oil having roughly 75% of the strength of plain concrete at 28 days. At the age of one year the crushing strength of 1:3 mortar suffers but little with the addition of oil in quantities up to 10 per cent.

4. The toughness or resistance to impact is affected but slightly by the addition of oil in quantities up to about 10 per cent.

5. The stiffness of oil-mixed concrete appears to differ but little from that of plain concrete.

6. The results of tests for permanent deformation do not indicate that a law is followed by oil-mixed concrete.

7. Oil-mixed mortar and concrete containing 10% of oil have very little absorption, and, under low pressures, both are water-proof.

8. Oil-mixed mortar containing 10% of oil is absolutely water-tight under pressures as high as 40 lb. per sq. in. Tests indicate that oil-mixed mortar is effective as a water-proofing agent when plastered or painted on either side of porous concrete.

9. Bond tests show the inadvisability of using plain bar reinforce-

ment with oil-concrete mixtures. With deformed bars the bond is not weakened seriously by the addition of oil in quantities up to 10 per cent.

A patent has been granted to the writer for mixing oil with Portland cement concrete and hydraulic cements giving an alkaline reaction. All citizens of the United States are at liberty to use this process without the payment of royalties.

The writer takes this opportunity to express his thanks to A. S. Cushman, Assoc. Am. Soc. C. E., and Mr. A. T. Goldbeck for their most valuable assistance in conducting these experiments.

Vol. XXXVII. SEPTEMBER, 1911. No. 7.

AMERICAN SOCIETY OF CIVIL ENGINEERS
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PAPERS AND DISCUSSIONS

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REINFORCED CONCRETE BRIDGE ACROSS THE ALMENDARES RIVER, HAVANA, CUBA.

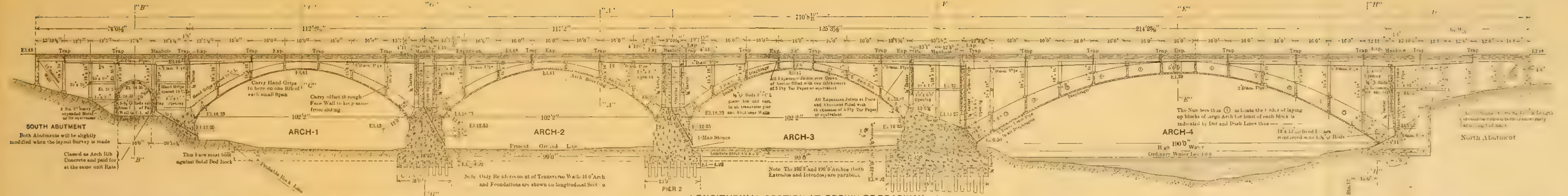
By Eugene Klapp and W. J. Douglas, Members, Am. Soc. C. E.

To be Presented November 1st, 1911.

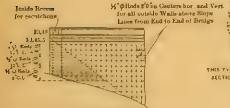
The Almendares River Bridge (in the Province of Havana) crosses the Almendares River and connects the City with the suburb of Marianao. The construction of this concrete bridge was begun in November, 1908, and was completed in August, 1910. It is designed to carry highway traffic, and includes a double track for street cars. The live load was assumed as follows: On either car track, a concentrated load of 24 tons; on any other portion of the roadway, a wagon-load of 12 tons; on the sidewalks and for the arch design over the entire bridge, 100 lb. per sq. ft. of floor. The following are the principal dimensions: total length, 711 ft.; height, above the ordinary water level, 48 ft.; roadway, 24 ft. wide; each of two sidewalks, 5 ft. wide. The bridge is paved with granite blocks resting on 1 in. of paving sand.

The structure consists of three spans of 102 ft. 2 in., having a rise of 22 ft. 8 in., and one span of 190 ft., having a rise of 32 ft. 6 in. The small arches are separated from each other by piers 15 ft. wide, and the large arch is separated from the adjacent small one by a pier 34 ft. wide, all measured at the springing lines.

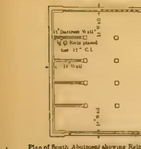
Note.—These papers are issued before the date set for presentation and discussion. Correspondence is invited from those who cannot be present at the meeting, and may be sent by mail to the Secretary. Discussion, either oral or written, will be published in a subsequent number of *Proceedings*, and, when finally closed, the papers, with discussion in full, will be published in *Transactions*.


710'8½"
74'0¼"
112'3⅞"
125'3⅝"
214'2⅝"
ARCH-1
ARCH-2
ARCH-3
ARCH-4
102'2"
190'0"
SOUTH ABUTMENT
Both Abutments will be slightly modified when the layout Survey is made
Classed as Arch Rib Concrete and paid for at the same unit Rate
This Face must butt against Solid Bed Rock
Probable Rock Line
Carry Hand Grips to here on one Rib of each small Span
Carry offset through Face Wall to keep paint from sliding
Present Ground Line
1-Man Stones
All Expansion Joints over Crown of Arches filled with two thicknesses of 3 Ply Tar Paper or equivalent
All Expansion Joints at Piers and Abutment filled with the thickness of 3-Ply Tar Paper or equivalent
Note: Only Reinforcement of Transverse Walls 16'0" Arch and Foundations are shown on longitudinal Section
Note: The 102'2" and 190'0" Arches (both Extrados and Intrados) are parabolas
The Numbers thus ① indicate the order of laying up blocks of large Arch the limit of each block is indicated by Dot and Dash Lines thus
High Water
Ordinary Water Lev. 100
North Abutment
PIER 1
PIER 2
PIER 3
Trap
Manhole
Exp.

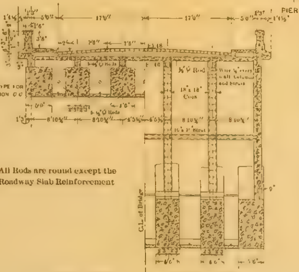
LONGITUDINAL SECTION AT CROWN OF ROADWAY


Inside Recess for escutcheons
½"φ Rods 2'0" Centers hor. and Vert. for all outside Walls above Slope Lines from End to End of Bridge

Reinforcement for South Abutment
Reinforcement for North Abutment Similar



Plan of South Abutment showing Reinforcement
North Abutment Similar



All Rods are round except the Roadway Slab Reinforcement

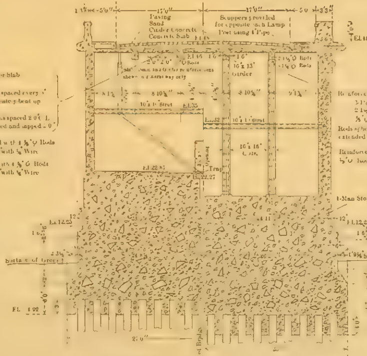
SECTION "EE"
Half Section Through Crown of 190'0" Arch

SECTION "HH"
Half Section Through 190'0" Arch

Reinforcement of Floor Slab
Transversal
⅜"φ Bars spaced every 6" and alternately bent up
Longitudinal
⅜"φ Rods spaced 2'0" C.L. as indicated and lapped 2'0"

All Columns reinforced with 4 ⅝"φ Rods and wrapped every 15" with ⅛" Wire

All Struts reinforced with 4 ⅝"φ Rods and wrapped every 15" with ⅛" Wire

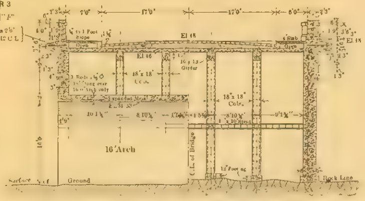


Reinforcement for all 16"x 13" longitudl Girders
3 1¼"φ Rods straight
2 1¼"φ Rods turned up over Column Points
⅜"φ Stirrups spaced every 9"
Rods spliced at Column Points and each Rod extended 4' on both sides of C.L. of Column

Reinforcement of Face Walls
½"φ Rods placed hor. and vert. 2'0" C.L.

SECTION "GG"
Half Section Through Piers 1 and 2

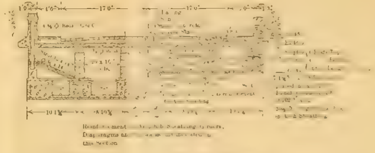
SECTION "FF"
Half Section Through Pier 3



SECTION "BB"
Half Section Through South Abutment

SECTION "DD"
Half Section Through North Abutment

Lap of ⅜"φ	Rods	2'0"
½"φ	"	2'0"
⅝"φ	"	2'0"
¾"φ	"	2'6"
1"φ	"	3'0"
1¼"φ		3'6"
1½"φ	"	4'0"

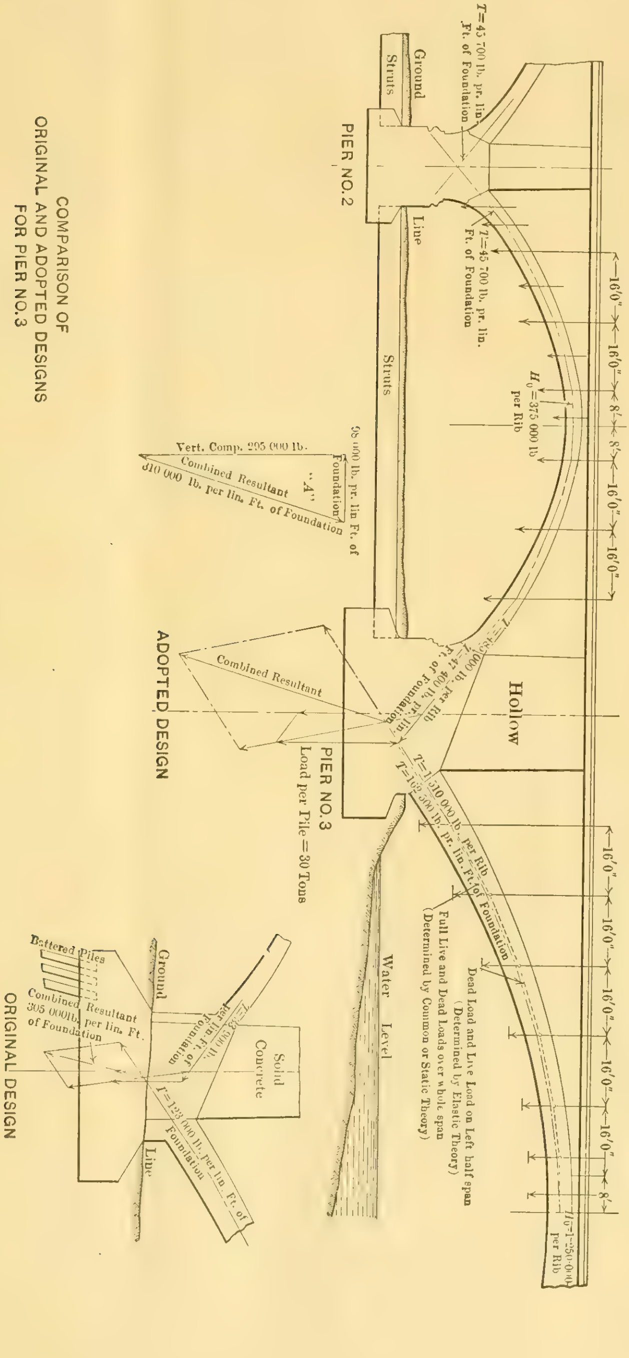


Reinforcement [illegible]
Diaphragms [illegible]
this Section

SECTION "LL"
Half Section Through Lamp [illegible]

SECTION "CC"
Half Section Through Crown of 102'2" Arch

CONCRETE BRIDGE OVER ALMENDARES RIVER,
HAVANA, CUBA.


T=45 700 lb. pr. lin. Ft. of Foundation
Ground
Struts
PIER NO.2
Line
T=45 700 lb. pr. lin. Ft. of Foundation
Struts
H_0=375 000 lb per Rib
16'0"
16'0"
8'
8'
16'0"
16'0"
98 000 lb. pr. lin Ft. of Foundation
Vert. Comp. 295 000 lb.
"A"
Combined Resultant
310 000 lb. per lin. Ft. of Foundation
T=143 000 lb. per Rib
T=47 400 lb. pr. lin. Ft. of Foundation
Hollow
Combined Resultant
ADOPTED DESIGN
PIER NO.3
Load per Pile=30 Tons
T=1 510 000 lb. per Rib
T=162 500 lb. pr. lin. Ft. of Foundation
16'0"
16'0"
16'0"
16'0"
16'0"
8'
Dead Load and Live Load on Left half span (Determined by Elastic Theory)
Full Live and Dead Loads over whole span (Determined by Common or Static Theory)
H_0=1 250 000 per Rib
Water Level
Battered Piles
Ground
Combined Resultant 305 000 lb. per lin. Ft. of Foundation
T=33 000 lb. per lin. Ft. of Foundation
Solid Concrete
T=123 000 lb. per lin. Ft. of Foundation
Line
ORIGINAL DESIGN

COMPARISON OF
ORIGINAL AND ADOPTED DESIGNS
FOR PIER NO.3

FIG. 1.

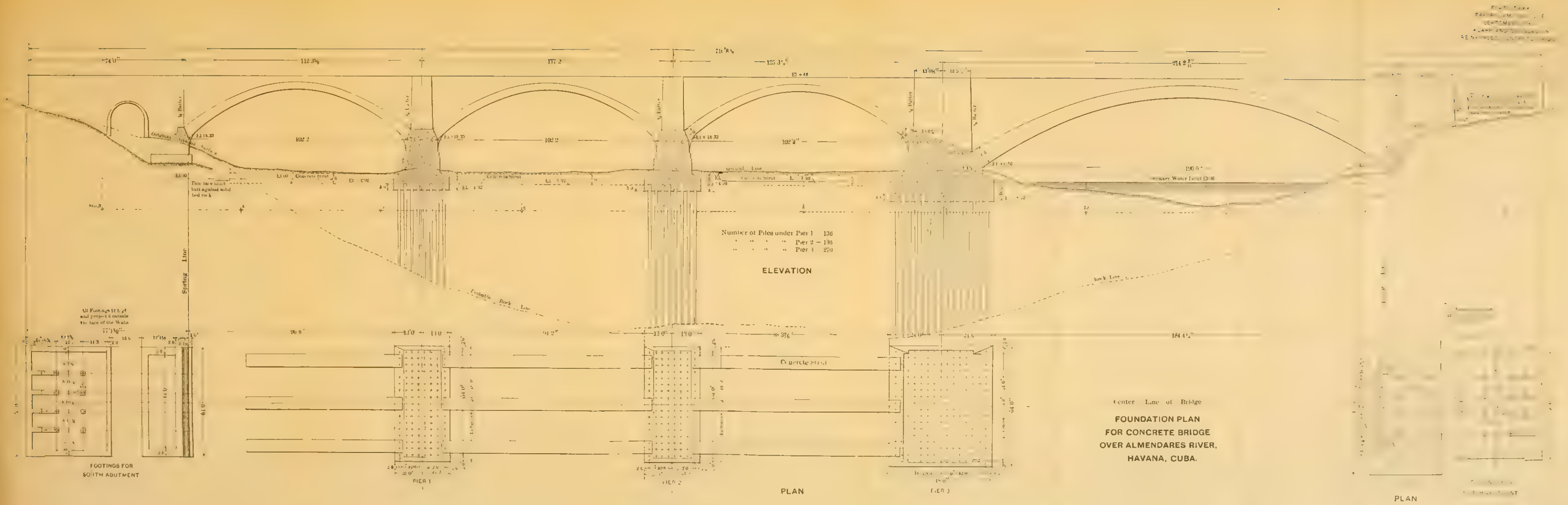
The ends of the bridge terminate in abutments approximately 70 ft. long, which appear to be of the **U** type, but were designed and built hollow, with interior buttresses to take care of the thrusts of the exterior earth.

All the piers rest on pile foundations driven to rock, the latter being of coral formation. The general design of these foundations is shown on Plates CXXIX and CXXX. The arch abutments at either end of the bridge rest on coral rock. Hard rock was found at the south end, and a soft coral bed, which will be referred to in detail later, was found at the north end, where a solid foundation was much desired, in order to take the thrust of the large arch. The hollow abutment walls and buttresses rest on a firm, but rotten, coral rock, which is strong enough to take care of the light loads.

The contract drawings were made on the assumption that hardpan or solid rock would be encountered at a higher level than the subsequent test piles determined it to be. From the information obtained, the design for Piers Nos. 1 and 2 was changed from spread, reinforced concrete footings to pile footings, and Pier No. 3 was designed with vertical, instead of inclined, piles. In the original design, anticipating short piles, it was thought more economical to drive batter piles, as shown by Fig. 1, the inclination of the latter agreeing with the resultant thrust of the two arches resting on this pier.

On account of the softness of the foundations, it was, of course, highly desirable to build a bridge of equal spans, in order to have vertical pressures on all piers and to get rid of the enormous unbalanced horizontal thrust on Pier No. 3. Local conditions, however, and especially the insistence of the Government, determined a span of 190 ft. over the river proper, and appearance prohibited the adoption of two flat arches of equal spans to cover the remainder of the distance between the south end of the large arch and the south abutment. Further, computations indicated that no material economy would be gained by using two approach arches in lieu of the three finally adopted.

It should be noted that, in the original design, Fig. 1, it was necessary to use a large mass of concrete above the springing lines of the arches resting on Pier No. 3, in order to force the resultant thrust to a more nearly vertical line. This load was undesirable because of the added cost and the increased load on the piles. To



FOUNDATION PLAN
FOR CONCRETE BRIDGE
OVER ALMENDARES RIVER,
HAVANA, CUBA.

decrease the leverage of the unbalanced horizontal thrust on the piles, the springing line of the large arch was made as low as possible and that of the adjacent small-span arches as high as possible. On account of the heavy loads brought on the foundations of Piers Nos. 1 and 2, it was not thought economical to increase further the thrust of Arch No. 3 on Pier No. 3, by building all the smaller arches of the retaining-wall and earth-fill type.

The piles of the foundations were designed to carry 30 tons each, and to be driven to such refusal as was necessary to carry this load, based on the *Engineering News* formula, in which the safe load is represented by the well-known expression, $S = \frac{2\,Wh}{s + 1}$. However, as they were actually driven to rock, they could properly be considered as columns stiffened by the surrounding clay, but independent of skin friction for the transfer of the vertical load.

After test piles had been driven to develop the rock line, it was found that the rock, on which the piles of Pier No. 3 rest, was inclined with a sharp angle to the south, and that the inclination was in the same direction as that of the battered piles of the original design, and this fact, together with the great length of the piles, necessitated the abandonment of the original battered-pile plan.

At that time several other designs for this foundation were studied. A system of vertical piles with inclined caissons was considered, and also a foundation entirely of caissons. After a careful study of these types, it was finally decided to resolve the thrust into horizontal and vertical components, taking the latter component by piles driven vertically, while all the unbalanced horizontal thrust was taken care of by three lines of horizontal concrete struts extending from the south side of Pier No. 3 to, and beyond, Piers Nos. 1 and 2, to a firm rock resistance. These struts are shown on Plates CXXIX and CXXX, and on Fig. 1, Plate CXXXII. They were supported on piles driven at 10-ft. intervals. Although the ground was sufficiently firm to carry them, it was thought advisable, on account of the pier excavations at either end of each set of struts, to support them on separate pile foundations.

On account of their great length, the piles for the piers are of Georgia pine, the native Cuban piles being too short. Their average length is 56 ft. under Pier No. 1, 60 ft. under Pier No. 2, and 45 ft.

under Pier No. 3. The struts were built with construction joints between them and the abutting piers, in order to permit the piers to settle under their loads without cracking the struts. A layer of paper was placed between the face of each pier and the abutting struts, which made effective sliding joints. Pier No. 1 settled $\frac{3}{8}$ in., Pier No. 2, $\frac{3}{4}$ in., and Pier No. 3, $1\frac{1}{4}$ in., without cracking the struts, and apparently without causing much settlement of their ends.

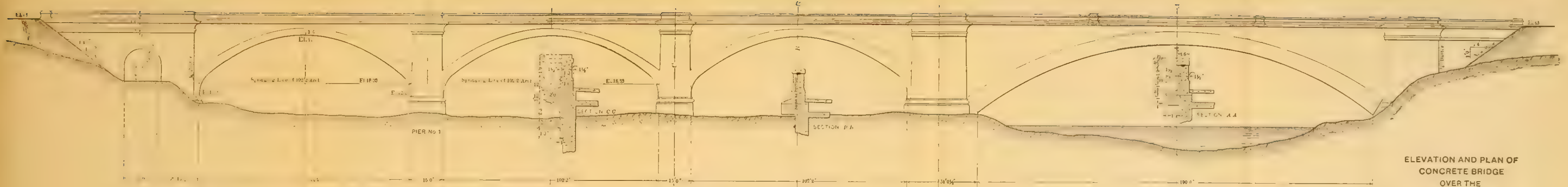
On account of the softness of the foundation bed and the necessity of carrying the arches on pile foundations, particularly where a large unbalanced horizontal thrust had to be taken care of, it was of vital import to reduce the weight of the structure to a minimum consistent with stability. It was decided, therefore, to build the bridge with hollow spandrels and hollow piers above the springing lines, and to build the arches in ribs, carrying the roadway on a concrete slab supported by concrete columns resting on the back of the arch ribs.

The arch ribs were tied together by concrete diaphragms, in order to take care of the tendency of the ribs to buckle as columns. The slenderness ratio of the inner arch ribs of the large arch unbraced was 1: 46, and that of the smaller arch 1: 40. This columnar ratio was further reduced, so as to be negligible, by the solid arch sheeting, which was introduced in the design for this purpose as well as for appearance.

As one of the foundations of the large span was compressible, it was deemed necessary to build it as a three-hinged arch, converting it into a solid arch by grouting in the hinges on the completion of the structure. The rib type of construction is well adapted for hinged arches. In the case of the smaller arches, the deepened arch resulting from the use of rib construction, instead of a solid arch sheet, is best adapted to short spans carrying heavy concentrated loads. For a given volume of masonry, the line of pressure in a deep ribbed arch may depart a greater distance, without going outside the middle third of the ring, thus causing tension, than it could in an arch built with a solid or continuous sheet.

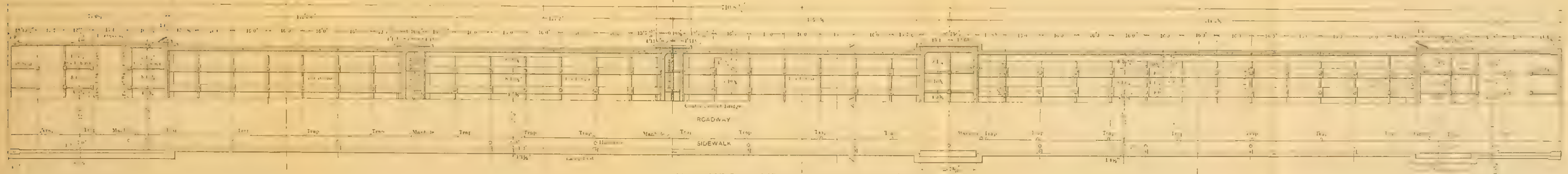
The detached rib design was further deemed desirable because the work was to be done at a considerable distance from the office of the designers. It gave, not only a better chance for inspection, but also a better opportunity to remove and replace any concrete of inferior quality which might by accident get into the work, and this seemed

PLATE CXXXI
PAPERS, AM. SOC. C. E.
SEPTEMBER, 1911
KLAPP AND DOUGLAS ON
REINFORCED CONCRETE BRIDGE.



SIDE ELEVATION OF BRIDGE

ELEVATION AND PLAN OF
CONCRETE BRIDGE
OVER THE
ALMENDARES RIVER,
HAVANA, CUBA.



HALF SECTIONAL VIEW AT TOP OF COLUMNS (PORTION XX)
HALF PLAN OF ROADWAY AND SIDEWALK (PORTION ZZ)

to be an asset, although the work was to be executed under their supervision.

A bridge somewhat cheaper and perhaps quite as satisfactory in appearance might have been designed by omitting the sheeting between the consecutive ribs and also the solid spandrel walls shown on several of the drawings and photographs. However, as this bridge was to be built in a country in which the prevailing style of construction is of massive design, it was thought better, from an artistic standpoint, to enclose the column construction and detached ribs by curtain or spandrel walls and sheeting.

Having decided on a cellular type of construction, the proper curves for these several arches determined themselves. Since the funicular polygon, or linear arch, for an arch loaded uniformly, in its horizontal projection is a parabola, it was decided to adopt this curve for all arches. For appearances, however, the parabola at the springing line of the smaller arches was made tangent to the piers. The true parabola and the modified form are shown on Plate CXXX.

The arches were designed by the common or static theory, it being assumed that the line of pressure lying generally nearest the neutral axis of the arch was the true one. After the thickness of the several arches had been determined, the line of pressure was computed and located by the elastic theory, checking very closely with the common or static theory.

Fig. 1 shows the lines of pressure in the large and small arches. The line of pressure shown in the small arch is for dead load, and the full line of pressure shown on the large arch is for full live and dead loads over the whole span. This line of pressure (and that for the small arch) was determined by the common or static theory, and the dotted line of pressure was determined by the elastic theory. The difference between the two lines for the large arch is shown to be almost negligible, and, as a matter of fact, the lines of pressure, as determined by the two theories for the same loading, were so close as to be practically coincident, and could not be shown on this small-scale drawing.

The line of pressure determined by the common method, not only for this bridge, but for other concrete bridges analyzed by the writers, agrees so closely with that determined by the elastic theory, that it is believed it can be used safely in design. However, in order to make an independent check, the elastic theory would best be applied after the final curves of the arches and their thicknesses have been determined. Many engineers object to the elastic theory, because it is difficult to understand, and, when used for the first or second time, it is difficult and slow of application. However, if many arches are to be designed in an office, the elastic theory can be applied almost as quickly as the common theory, and requires less mental effort. The writers have found that the elastic theory may be applied by most draftsmen or computers without a great amount of study.

As this bridge was to be built in the tropics, the effect of temperature was hardly worth considering; but, in determining the maximum stresses, a range of 20° was allowed for. The writers are of the opinion that the result of considering temperature, in accordance with the elastic theory, is far from satisfactory, particularly where the arches are built in voussoirs or alternate blocks, or where the deformation of the centering will be so great that construction cracks will occur as the work is carried up. Further, unless the arches are heavily reinforced, they cannot develop the requisite amount of tension to make the structure act as an elastic arch under a change of temperature of 10 or 15°, depending, of course, on the rise and span of the arch.

Fig. 1 shows the resultant line of pressure on the foundations of the original design, the piles being driven parallel to the line of pressure, and each pile being designed for a pressure of 26 tons. In this design it was necessary to put in a heavy steel reinforcement for that portion of the foundation projecting beyond the neat lines of the pier proper, thus treating these projections as cantilevers. Fig. 1 also shows the design finally adopted for Pier No. 3, the piles being driven vertically to take the vertical component of 295 000 lb. per lin. ft. of foundation, and horizontal struts being introduced to take the horizontal thrust of 98 000 lb. per lin. ft.

The arches were designed so as to keep the line of pressure within the middle third, no steel being necessary to take any computable tension. Steel reinforcement was used, however, as an additional factor of safety, and was regarded as reducing the compressive stresses in the concrete, based on the moduli of elasticity of the steel and concrete.

The sizes of the ribs were determined by theory and on the assumption that no reduction in the allowable unit compression was

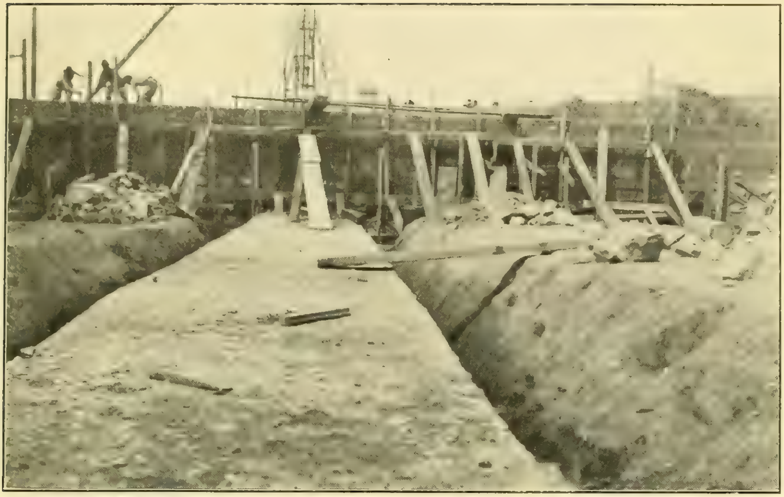


FIG. 1.—CONCRETE STRUT, 6 BY 6 FT.

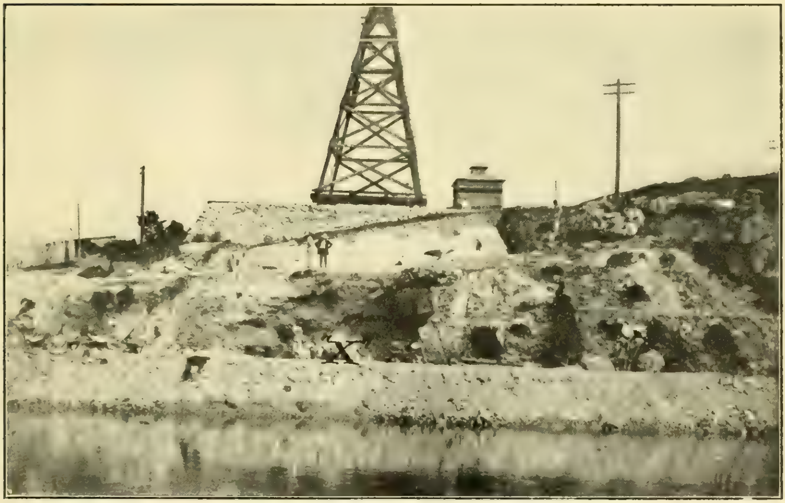


FIG. 2.—NORTH ABUTMENT EXCAVATION, SHOWING CAVE HOLES IN BANK.

necessary on account of columnar action. The size and reinforcement of the transverse diaphragms and the thickness of the arch sheeting were matters of judgment rather than computation. The interior arch ribs support the reinforced concrete columns which, in turn, support the longitudinal beams or girders carrying the floor slab. In the original design longitudinal beams and transverse girders were used, but these were omitted in the final design, Plate CXXIX, in order to simplify construction and reduce the cost of form work, which, requiring experienced labor, is particularly expensive in the tropics. The longer columns on the piers were braced by horizontal struts, shown on Plates CXXIX and CXXXI.

Several designs were made of the abutments, using gravity sections and buttressed reinforced concrete ones. These designs showed clearly that the hollow reinforced concrete type, the exterior walls acting as beams to carry the earth thrust and supported by interior buttresses, was materially cheaper. This type, shown on Plates CXXIX and CXXXI, was adopted.

The architectural features of the original design were made extremely simple, on account of the lack of funds. Considerable attention, however, was given to the proper proportions of the various parts, the depth of the arch ring and the width of the piers being determined by the actual needs of the structure. After bids were taken, it was found that a small amount of ornamentation was permissible, and William M. Black, M. Am. Soc. C. E., Colonel, Corps of Engrs., U. S. A., then Engineer Advisor to the Government of Intervention, called into consultation Mr. T. S. Newton, an architect, to suggest modifications of the architectural details. Mr. Newton's suggestions were of such excellence that the designers gladly availed themselves of them, and modified the bridge design accordingly, materially improving its appearance. The writers believe such cooperation of architects with engineers to be far too infrequent.

Plate CXXXI shows an elevation and plan of the bridge, and horizontal cross-sections at the tops of the columns.

The outer ribs of the large span were reinforced with five 1-in., round rods extending the entire length, and on account of the eccentric load on this rib (see Section *E-E*), seven $1\frac{1}{4}$-in. rods, 4 ft. 8 in. long, were placed in each 16-ft. panel. The eccentricity on the outer ribs of the large arch amounted to 1 ft. 3 in.

Each diaphragm (Plate CXXXIII) was reinforced with eight $\frac{3}{4}$-in.

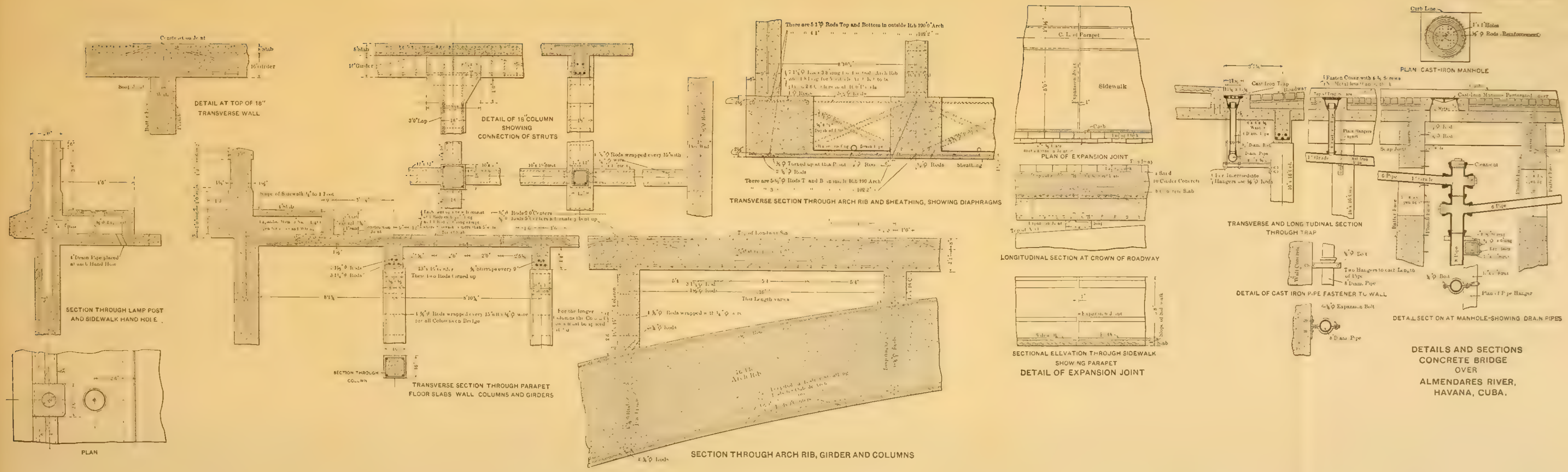
round rods extending well into the adjacent ribs. In addition, there were two ¾-in. rods at the top and bottom of the arch ribs, extending transversely across the bridge from side to side and through the diaphragms.

The arch sheeting, which was placed after the ribs had been concreted, was beveled, as shown on the transverse section through the arch rib (Plate CXXXIII), so as to be independent of the ⅜-in. transverse rods, for retaining its position. The reinforcement of this sheet not only carries the dead-weight tension of the sheeting and any live load which may accidentally come on it, but also forms, with the concrete, an efficient and continuous lateral bracing, the concrete composing the compression members, and the steel reinforcement the tension ones.

The reinforced concrete columns are doweled to the arch ribs by the column reinforcing rods, and the concentrated load brought by the columns is in part distributed over the arch ribs by the two ¾-in. round rods extending across the arch. The top of the columns is sufficiently bonded to the beams by the bending of the column rods, as shown on the transverse section on Plate CXXXIII. The longitudinal beams were designed with the same amount of steel over the supports as at the middle of the beam, and were computed on the basis of $\frac{1}{12} w l^2$. Shear bars somewhat in excess of existing practice were provided, but, at the time the design was made, the question of shear or diagonal tension was even more indefinite than at present, and every precaution was taken to ensure the beams against such failure. The tops of the 18-in. columns were provided with knee braces to stiffen them, and these columns were increased in cross-sectional area on account of their greater length. The interior ribs of the large arch were reinforced with five ½-in. round rods near the intrados and extrados. The design of the smaller arches was similar to that of the large one.

A very complete drainage of the roadway and the interior of the bridge was provided, as shown on Plates CXXIX and CXXXIII. The drains were designed so as to carry the water off readily, and so that they could be cleaned without much trouble. The system of drainage is somewhat more expensive than that commonly used in the design of concrete bridges, but, particularly with a bridge of the

PLATE CXXXIII.
PAPERS, AM. SOC. C. E.
SEPTEMBER, 1911.
KLAPP AND DOUGLAS ON
REINFORCED CONCRETE BRIDGE.


Construction Joint
Slab
16" Girder
Sidewalk
C. L. of Parapet
Curb
Curb Line
1 ½" Holes
Cast-Iron Trap
Roadway
Cement
6" Pipe
Sheathing
¾" Bolt
Two Hangers to each Length of Pipe
8" Drain Pipe
⅝" Expansion Bolt
Plan of Pipe Hanger
There are 5 1" Rods Top and Bottom in outside Rib 190'0" Arch
This Length varies
Arch Rib
4" Drain Pipe placed at each Hand Hole
Slope of Sidewalk ½" to 1 Foot
13" x 18" Girder
⅜" Stirrups every 9"
1 ¼" Rods wrapped every 15" with ⅛" wire for all Columns on Bridge
For the longer columns the Columns must be spliced

DETAIL AT TOP OF 18" TRANSVERSE WALL

DETAIL OF 18" COLUMN SHOWING CONNECTION OF STRUTS

SECTION THROUGH LAMP POST AND SIDEWALK HAND HOLE

PLAN

SECTION THROUGH COLUMN

TRANSVERSE SECTION THROUGH PARAPET FLOOR SLABS WALL COLUMNS AND GIRDERS

SECTION THROUGH ARCH RIB, GIRDER AND COLUMNS

TRANSVERSE SECTION THROUGH ARCH RIB AND SHEATHING, SHOWING DIAPHRAGMS

PLAN OF EXPANSION JOINT

LONGITUDINAL SECTION AT CROWN OF ROADWAY

SECTIONAL ELEVATION THROUGH SIDEWALK SHOWING PARAPET

DETAIL OF EXPANSION JOINT

PLAN CAST-IRON MANHOLE

TRANSVERSE AND LONGITUDINAL SECTION THROUGH TRAP

DETAIL OF CAST IRON PIPE FASTENER TO WALL

DETAIL SECTION AT MANHOLE-SHOWING DRAIN PIPES

DETAILS AND SECTIONS
CONCRETE BRIDGE
OVER
ALMENDARES RIVER,
HAVANA, CUBA.

hollow type, it was thought that the drainage should be efficiently taken care of in order to prevent any impounding of water within the curtain-walls.

The design of the abutments was made on the basis of an earth thrust of 12.5 h^2, and above the slope lines the walls were reinforced with $\frac{1}{2}$-in. rods, 24 in. on centers, in both horizontal and vertical directions, in order to take care of the shrinkage cracks. Expansion joints at the piers were made as shown on Plate CXXXIII.

In introducing the large horizontal struts to take care of the unbalanced horizontal thrust on Pier No. 3, it was foreseen that the thrust of the large arch would shorten the struts between Piers Nos. 3 and 2, and 2 and 1, and that this shortening would probably cause a rise in the crown of Arches Nos. 3 and 2. Measurements taken during the construction, as hereafter described, showed a material shortening of the struts, but did not show the rise of the arch crowns. This was probably due to the fact that the concrete, after it had set, lost the heat of setting, thereby tending to cause the arch ribs to shorten, and, further, the added loads of the columns and the floor-slab also tended to shorten the ribs and to lower the foundations, which lowering affected the arches to the same extent.

During extreme high water the water rises above the ground level between the smaller arches, and in a recent freshet, during a November cyclone, it rose to the height of the springing lines of the smaller arches. Though the current was sufficient to wash away the pontoon bridge adjacent to the site and otherwise damage the neighboring property, no scour occurred at these struts.

It was necessary to provide an opening through the south abutment sufficiently large for the passage of two teams abreast. This opening is shown on Plates CXXIX and CXXXI. It has a span of 16 ft., and sufficient rise for the passage of vehicles.

The backs of all arches and intermediate sheetings are covered with two coats of coal-tar, in order to reduce unsightly seepage to a minimum, and drain pipes are provided, so that water may pass down the sheeting and be drained out near the springing line.

At various points along the bridge 10-in. wrought-iron pipes, about 9 ft. long, are set in the outside wall to provide for pockets in which lamp standards may be subsequently placed. These standards will be of sufficient size to serve for trolley poles if required. The details of the pipes and reinforcing steel are shown on Plate CXXXIII, and their locations are shown on the half plan of the roadway, Plate CXXXI. In order to stiffen this somewhat thin outside wall against the kick of the lamp-post, if used as a trolley pole, the struts shown on Section *A-A*, Plate CXXIX, were introduced.

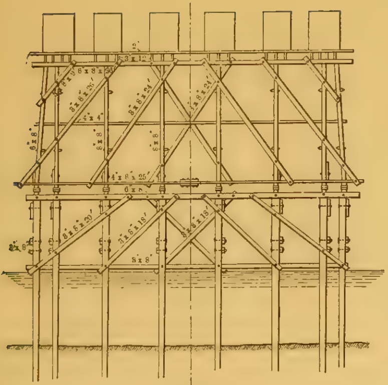
Calcareous sand was used in making the concrete for the bridge; this material is used in practically all Cuban work. Briquette tests, made from time to time, indicated that, when washed so as to be reasonably free from clay and mixed with Portland cement, the tensile strength is about 75% of that of similar briquettes made with standard Ottawa sand.

The sand was taken from sand-pits containing grains of varying coarseness and considerable clay. The washed sand contained not more than about 4% of clay, and showed a higher tensile strength than that containing about 7 per cent. The broken limestone used in the concrete was of varying hardness. It was difficult to obtain stone of proper hardness and reasonably free from clay. Compression tests on concrete containing small percentages of clay gave low results. Portland cement, manufactured by the Almendares Portland Cement Company, whose works are about 500 ft. from the south end of the bridge, was used in the construction of the bridge. This cement had been used successfully by the National Bureau of Public Works, and was accepted by the engineers of this bridge after passing the standard tests for American cements.

All steel reinforcement was purchased in the United States, and was tested before shipment to Cuba. The concrete was composed of 1 part cement and 7½ parts aggregate. The aggregate was composed of approximately 2½ parts of sand to 5 parts of broken stone, the exact relation of the sand to the broken stone being determined from time to time by the resident engineer in order to obtain a concrete of maximum density. The concrete was mixed in a Smith mixer of ½ cu. yd. capacity, and was conveyed from the mixer (beyond the south end of the bridge), by a cableway supported on fixed towers, to the point in the work where it was to be used. The materials for the concrete were hauled by teams and dumped from an elevated structure adjacent to the mixer.

Power saws were not used. Bends in the reinforcing steel sharper than 60° were made hot.

CENTERING FOR ARCHES OF ALMANDARES RIVER BRIDGE HAVANA, CUBA



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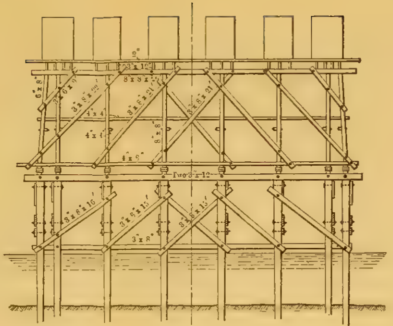

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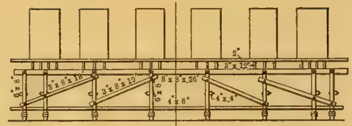

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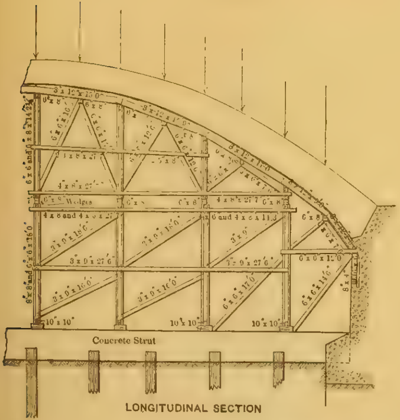
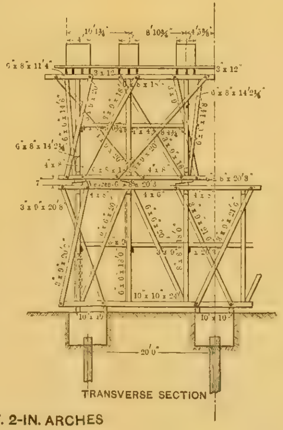
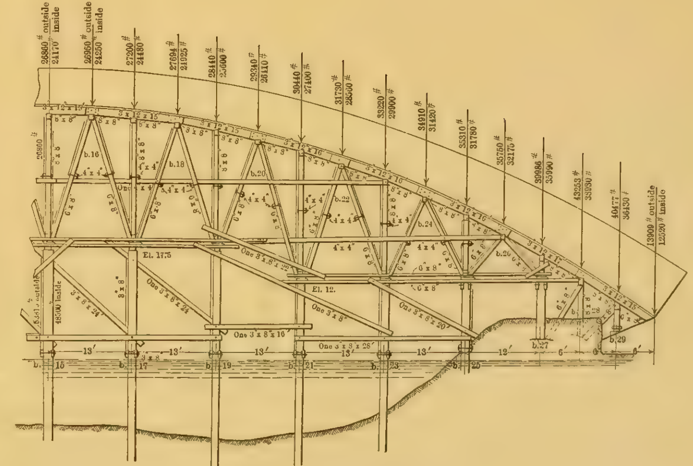


LONGITUDINAL SECTION



TRANSVERSE SECTION

CENTERING FOR 102 FT. 2-IN. ARCHES



CENTERING FOR 190-FOOT ARCHES

The contractor was required to carry up the exposed walls so as to bring the work to a horizontal joint at the close of each day, in order to make all the joints horizontal and regular. To ensure this result, the top surface of the day's work was tamped to a straight edge. In arch work the block joints were made radial so that the work of different days is shown by radial joints, care having been taken to build the arch bulkheads radially true and straight. An attempt was made to fasten the arch forms together by wire, but this resulted in somewhat unsightly work, with small and irregular bulges, and, in consequence, the ties were changed to $\frac{3}{4}$-in. bolts, designed so that their ends were removable after the work had been set up.

All exposed concrete faces were carefully spaded, so that there are no unsightly patches in the face work. Laborers in Cuba are not accustomed to this grade of concrete work, and it was found quite difficult to secure men to do the spading effectively, but after many attempts, two or three men were broken in, and satisfactory results were obtained. The bridge has not been tooled, except a small part of the inside portion of the parapet and the top of the hand-rail, but it is certain that dressing would not have added much, if anything, to its general appearance. This is partly due to the softness of the calcareous sand, which makes the concrete unsuitable for hammer work. After hammering the inside of the parapet, it was seen that the result was less satisfactory than rubbed work, and this latter method was finally adopted for the inside of the parapet and the top of the hand-rail. On work of this magnitude, the small form markings and occasional lipping streaks are not seriously objectionable, except for such portions of the parapet as are seen at close range.

The centering for the arches was designed by the Contractor's Engineer, T. T. Allard, M. Am. Soc. C. E., and approved by the Consulting Engineers. The design for the centering of the large arch is shown on Plate CXXXIV. Georgia pine lumber was used throughout, except for the wedges, where hard wood was used. The centering for the main arches was supported on piles, each pile carrying a load of approximately 30 tons. It was designed to carry only the dead weight of the arch rib. The centering for the smaller arches was supported in part by timbers resting on the concrete struts (which were used to take the unbalanced horizontal thrusts of the main arch).

These struts were not designed for this purpose, but were so used without showing any material settlement.

In the design of this centering, it was required that the wedges should be of straight grain. The allowable stresses in all timbers were computed on the basis of one-fifth of the reasonable breaking strain, the proper columnar deductions being made. The joists, caps, and lagging were computed to have a deformation of not more than $\frac{1}{4}$ in. under the full load of the concrete, the concrete being calculated as a liquid weighing 125 lb. per cu. ft. No dependence was placed on nails, except for fastening the lagging. The crown of the large center was raised 4 in. above the intended final height, and the crowns of the smaller arches were raised 1 in. above their intended height, in order to allow for settlement. The deformation and settlement of this falsework will be referred to later.

On the longitudinal section, Plate CXXIX, the small figures, included within the circles on the large arch ring, show the order in which it was intended that these arch rings should be built up. Work was to be started at the crown and then progress toward the springing lines, all keying blocks marked 4 to be placed on the same day. The keying blocks were made as narrow as possible and still allow a man to work in them, so that after the main blocks had been placed (1, 2, and 3), these small blocks would not have sufficient weight to compress the centering a material amount.

Near the springing lines of this arch, two reinforced concrete pillars are shown, designed for supporting Block 3, it being intended that these pillars should be cast in advance of Block 3, and that on the hardening of this block the timber props, commonly used for supporting such a block, were to be removed, and this load was to be carried by the small concrete pillars. The main longitudinal reinforcement, in itself, would have been sufficient to carry the load, but the pillars were intended as an additional precaution. As a matter of fact, the angle of the soffit near the springing line is so flat that a block of concrete would not slide down the lagging of the center except under a severe shock. As described later, the method of constructing the large arch was somewhat modified, on account of the necessity of building it with hinges.

When the original design was made, it was thought that hard rock would be found for the foundations of the north abutment of the large

PLATE CXXXV.
PAPERS, AM. SOC. C. E.
SEPTEMBER, 1911.
KLAPP AND DOUGLAS ON
REINFORCED CONCRETE BRIDGE.

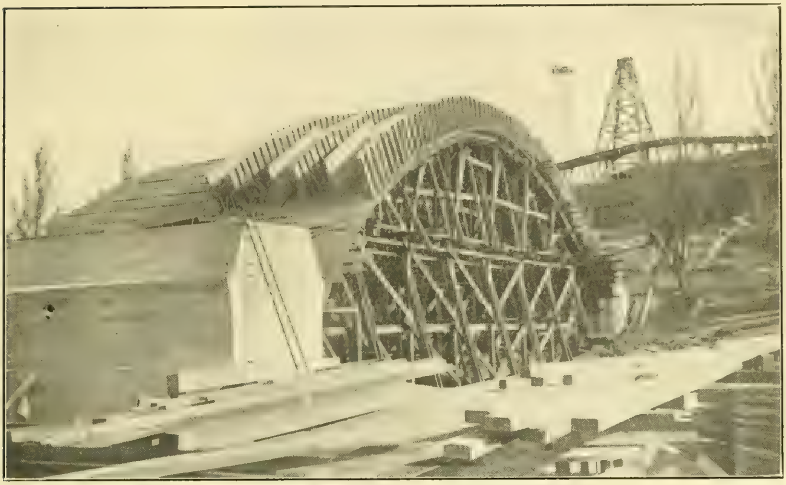


Fig. 1.—Centering for 102-Ft. Arch.

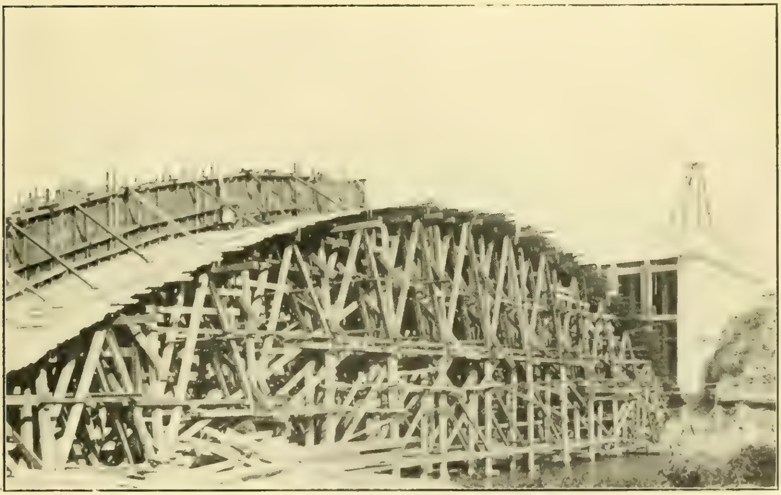
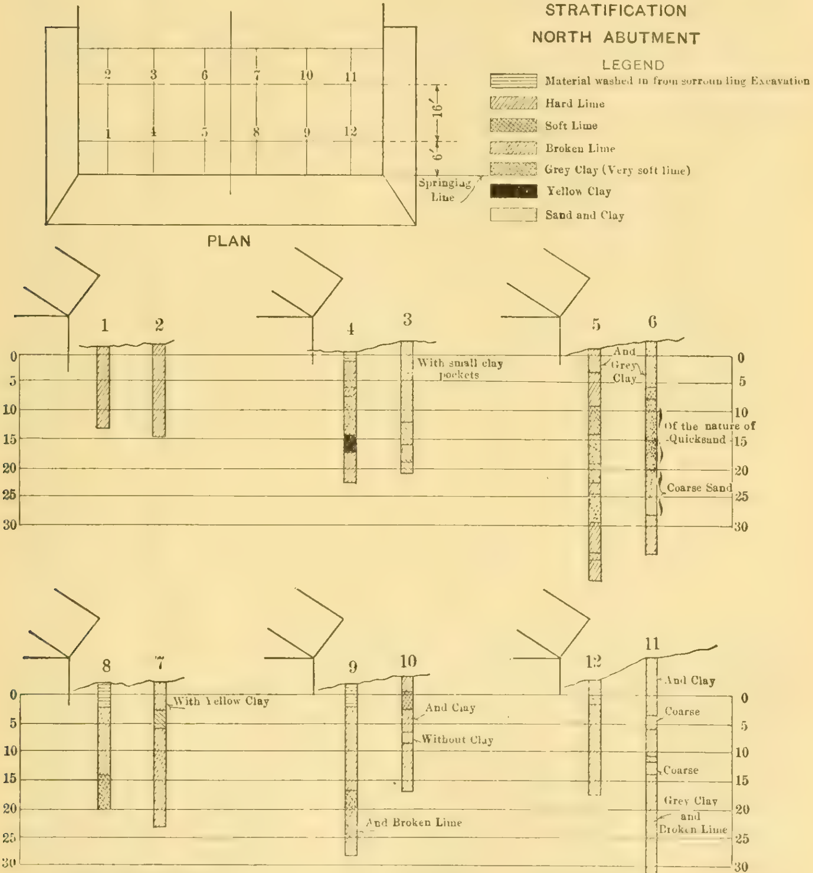


Fig. 2.—Centering for 190-Ft. Arch.

arch, but on digging down into this foundation bed a very inferior grade of coral rock, more or less decomposed, was encountered. Excavation was made to a depth of about 4 ft. below the natural surface of the ground, at the point marked "X" on Fig. 3 (also shown on Fig. 2, Plate CXXXII), and then was carried horizontally for about 34 ft. into the hill, forming a bank of decomposed coral rock at the back of the excavation. At that time some apprehension was caused by the apparent insecurity of the foundations for such a large span.



Hard Lime: Fine Flour . . . Rate of boring = 4 Ft. per day
Soft " : Coarser than Sand . . . " " " = 8 to 10 " " "
Broken " : Sand to gravel size of 1 in . . . " " " = 10 to 15 " " "
Grey Clay (Very soft lime) Flour in suspension . . . " " " = 40 to 60 " " "

Fig. 2.

It was thought unwise to go any deeper, as two borings indicated that better foundations would not be encountered at any practical depth. Before proceeding with the final design of this abutment, twelve additional bore holes were sunk, as shown on Fig. 2, demonstrating that better foundations would not be obtained at any reasonably greater depth, there being at least 20 ft. of decomposed coral rock below the bottom of the existing excavation. These borings were a necessary precaution, as the surrounding coral hills show the rock to be full of caves varying from a few cubic feet to 20 ft. in width and more in length. The existence of the larger holes under the foundations of this abutment, and not covered by a sufficient thickness of rock, would have been disastrous.

On the basis of the borings, it was decided to design this foundation as shown on Fig. 3, in which the horizontal concrete pad was computed to carry all the vertical load, and a similar pad of concrete at the back to carry all the horizontal thrust, except a small amount which would be taken by the bottom pad due to the roughness of the foundation bed. The foundation was designed on the basis of a load of 2½ tons per sq. ft. The exposed decomposed rock was sufficiently hard to have withstood a higher load per square foot, but the bore holes indicated the presence of small caves, from 2 to probably 12 cu. ft. in content, filled with clay, which was somewhat disconcerting. Similar cave holes had been encountered above the level of the footing, in the back part of the excavation, where the depth was about 16 ft. So many seams ran through this decomposed coral rock that small land crabs crawled through the bank without much difficulty.

On account of this foundation for the north abutment, and also due to the fact that the piles of Pier No. 3 averaged about 56 ft. in length, it was decided to build the large arch ribs as hinged arches, so that if the foundations settled the arch might deform without any initial strains or cracks.

Cast-steel hinges were out of the question, both on account of cost and appearance. Lead hinges were also too expensive. The hinges used consisted of cast-iron plates, 2 in. thick, covered with ⅛-in. sheet lead, to provide a proper bearing of the hinges on the concrete above and below them. The surfaces of the adjacent concrete were dressed true to receive the hinges. On account of the introduc-

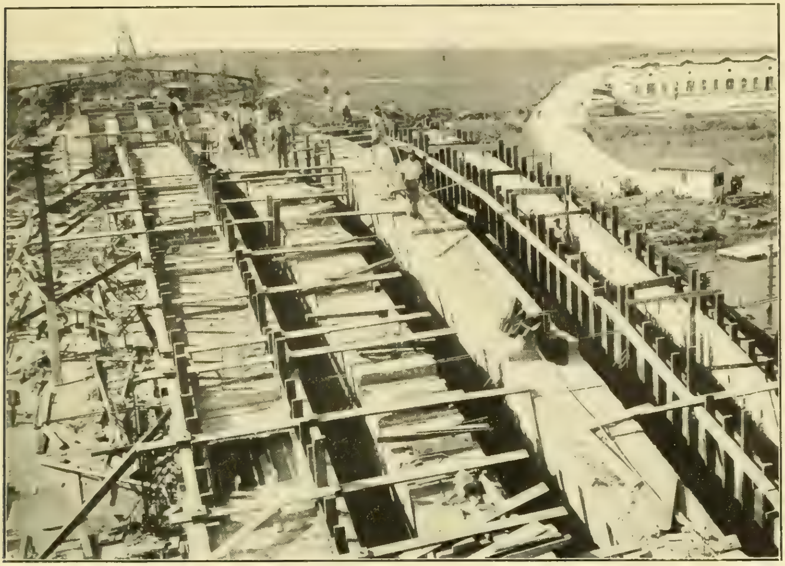


Fig. 1.—Arch Ribs and Forms of 190-Ft. Arch.

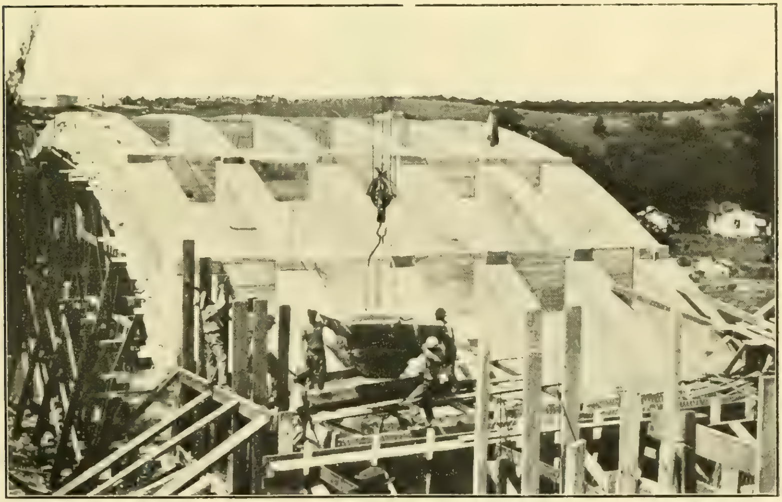
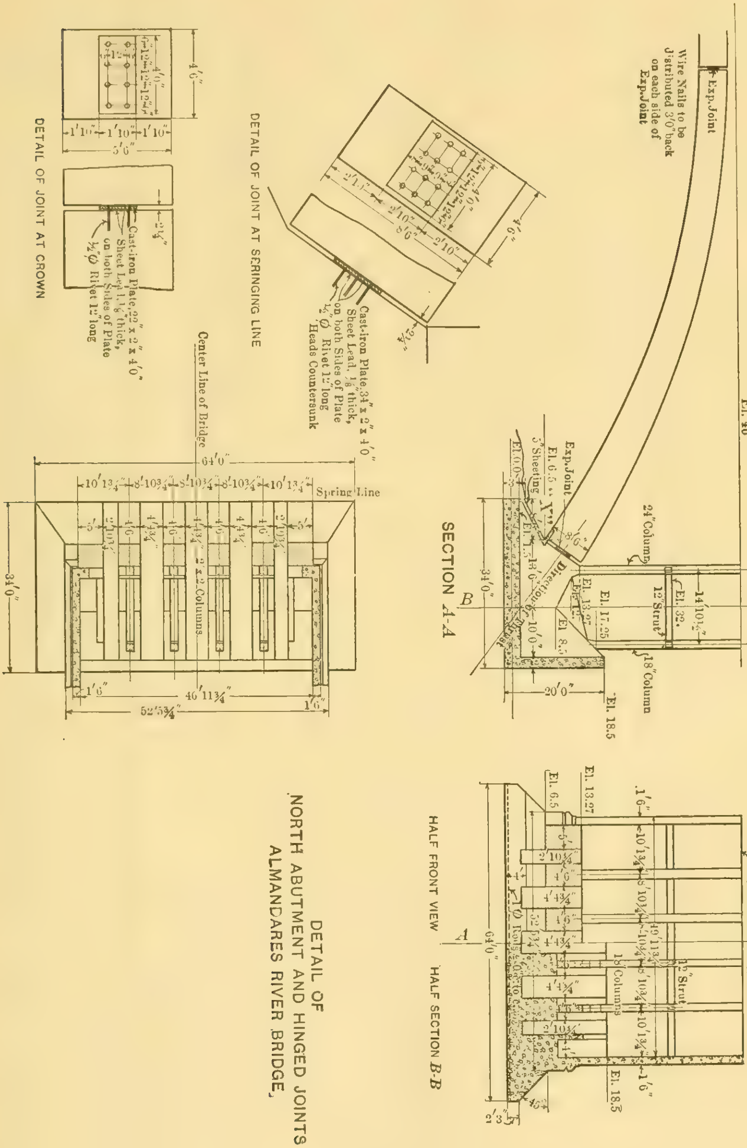


Fig. 2.—Top View of 102-Ft. Arch.



DETAIL OF
NORTH ABUTMENT AND HINGED JOINTS
ALMANDARES RIVER BRIDGE,

FIG. 8.

tion of the hinges, it was necessary to rearrange the size and order of laying the concrete blocks of the large arch. The order shown on Plate CXXXVII was followed, the lower large blocks being placed first instead of last, as originally shown.

In building each of the smaller arches, the six ribs were first built monolithically over the central half of the span, followed by the haunch sections, completing one rib at a time. In the case of Arch No. 1, the sheeting and diaphragms were built after the completion of the ribs, and in Arches Nos. 2 and 3, the diaphragms were built at the same time as the ribs, and then were followed by the sheeting. Some poor concrete got into Arch No. 1, which made it necessary to cut out three sections and replace them.

Each of the ribs of Arch No. 4 was built in eight monolithic sections, and keyed up, two ribs at a time, from haunch to crown. The ribs adjacent to, and on either side of, the longitudinal center line, were laid first, followed by those immediately adjacent to these central ribs, and finally by the outside ribs. The sheeting and diaphragms were laid after the completion of the ribs. After the removal of the centering, it was noted that the concrete showed the most lipping near the oldest ribs, which would indicate that they had developed arch action prior to the placing of the sheeting concrete.

By referring to the centering of the large arch, it will be noted that the falsework was tied together by inclined bracing, so that if one post settled under its load it would tend to force down the posts connected with it by the inclined bracing, and, therefore, if the central ribs had been keyed and the ribs adjacent to it were built, these new rib loads would tend to strike the centering under the central ribs, and, by similar reasoning, the outside ribs would tend to strike the centering under the intermediate ones, and possibly under the central ribs also. On account of this action, it has been found expedient to build large arches in transverse blocks or voussoirs, rather than in longitudinal rings.

In arches of reinforced concrete, say, up to a span of 100 ft., the longitudinal method is quite practical, because of the slight deformation of the falsework. In the case of detached arch ribs, the building of these ribs independently is essential to the construction, and the striking of the ribs by the ones subsequently built is not objectionable, provided, however, that the concrete of the first ribs placed is suffi-

SETTLEMENT OF ARCHES AND PIERS

SHORTENING OF STRUTS DURING CONSTRUCTION

ARCH No.1

DATE	1	2	3	4	5	6	7	8	9	
7-2-09	0.051	0.066	0.077	0.056	0.077	0.071	0.066	0.035	0.050	Started to concrete middle ribs 6-30-09. All points loaded, but points 1,2,3,7,8 and 9 had only half the final arch rib loads
7-4	0.061	0.066	0.108	0.076	0.103	0.103	0.075	0.045	0.056	2 middle ribs completed 7-3-09. All points loaded except points 1, 3 and 7 point 9 had only half the final arch rib loads
7-8	0.080	0.075	0.122	0.075	0.096	0.096	0.085	0.054	0.096	All arch ribs complete
7-15	0.097	0.094	0.115	0.089	0.089	0.107	0.086	0.055	0.076	
7-19	0.102	0.081	0.095	0.097	0.095	0.107	0.108	0.050	0.087	
7-19	0.095	0.079	0.121	0.087	0.093	0.103	0.109	0.032	0.079	
7-27	0.096	0.085	0.111	0.096	0.096	0.101	0.103	0.049	0.090	
7-28	0.096	0.096	0.127		0.096	0.101	0.106	0.056	0.096	
8-14	0.105	0.105	0.110	0.107	0.097	0.110	0.117	0.063	0.120	Sheathing and diaphragms completed 7-30-9.
9-29	0.103	0.106	0.124	0.103	0.110	0.113	0.113	0.066	0.108	Struck center.
10 1	0.103	0.106	0.132	0.103	0.114	0.121	0.116	0.067		Poured spandrels 4-6 and 7-10. Laid floor slab 4-22 to 26-10
1 21-10		0.095	0.131		0.105	0.113	0.121			

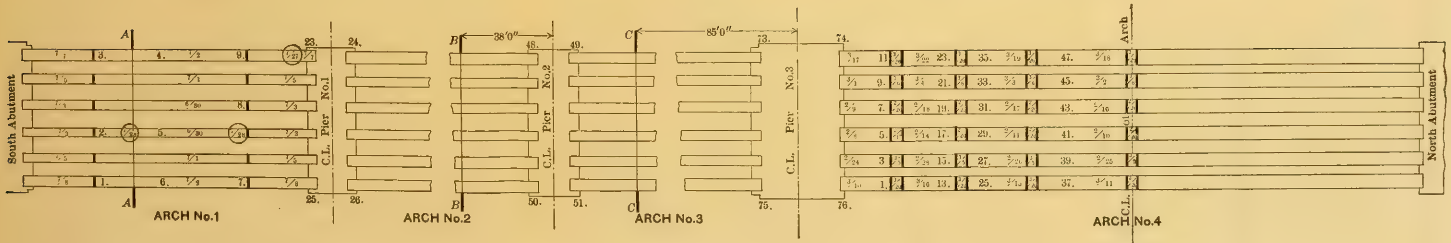
Arch completed 7-8-09, but two blocks near the crown of third rib from the East and one block in the most western rib were cut out and replaced as shown on plan below by figures enclosed in circles, delaying the completion of the arch to 7-28-09.

ARCH No.4

DATE	1	3	5	7	9	11	13	15	17	19	21	23	25	27	29	31	33	35	37	39	41	43	45	47	49	51	53	55	57	59	REMARKS
2-9-10		0.026	0.028	0.031					0.006	0.003																					Started to concrete middle ribs 2-8-10.
2-10-10																			0.005	0.018	0.048	0.008	0.012	0.015	0.011	0.008	0.030	0.021	0.007	0.013	
2-12 10	0.003	0.026	0.020	0.026	0.008	0.009	0.006	0.002	0.009	0.007	0.007	0.002	0.003	0.018	0.035	0.002	0.011	0.010	0.016	0.003	0.053	0.014	0.017	0.015	0.009	0.005	0.027	0.005	0.023	0.012	
2 15-10	0.008	0.030	0.025	0.034	0.002	0.007	0.001	0.004	0.050	0.027	0.000	0.001	0.007	0.013	0.051	0.028	0.001	0.007	0.023	0.063	0.045	0.021	0.004	0.008	0.004	0.001	0.041	0.029	0.021	0.012	
2 18-10																			0.008	0.009	0.073	0.056	0.028	0.004	0.002	0.009	0.062	0.056	0.000	0.000	All blocks of middle ribs laid except keying blocks.
2 19-10	0.006	0.024	0.010	0.048	0.017	0.005	0.005	0.030	0.070	0.058	0.020	0.005	0.001	0.022	0.085	0.074	0.016	0.005													2 middle ribs completed 2-20-10
2-26-10	0.015	0.070	0.052	0.053	0.012	0.000	0.012	0.034	0.035	0.052	0.025	0.069	0.000		0.109	0.126		0.002	0.007	0.035	0.070	0.071	0.020	0.014			0.050	0.055	0.015	0.006	
3 5-10	0.015	0.077	0.048	0.053	0.058	0.022	0.051	0.103	0.116	0.106	0.067	0.033	0.019	0.114	0.136	0.121	0.091	0.032	0.017	0.074	0.098	0.087		0.018	0.036	0.061	0.099	0.096	0.046	0.011	Intermediate ribs completed 3-5 and 3-6-10
3 25-10		0.090	0.061	0.063	0.068		0.085	0.132	0.129	0.116			0.122	0.150	0.156	0.136	0.125		0.093	0.109	0.097	0.118			0.099	0.104	0.127	0.134	0.054		All points loaded. Outside ribs complete 3-20 to & 3 [illegible]-10
4-12-10	0.082	0.087	0.053	0.054	0.056	0.043	0.088	0.129	0.123	0.111	0.105	0.101	0.111	0.139	0.140	0.136	0.120	0.068	0.080	0.103	0.084	0.103	0.101	0.100	0.090	0.094	0.113	0.120	0.029	0.070	Sheeting and diaphragm completed 4-3-10
5-1-10	0.113	0.120	0.073	0.072	0.075	0.066	0.095	0.146	0.146	0.131	0.130	0.120	0.137	0.164	0.171	0.149	0.143	0.093	0.106	0.123	0.113	0.132	0.122	0.123	0.110	0.113	0.133	0.145	0.064	0.089	
5-2-10																									0.103	0.103	0.124	0.131	0.052	0.079	Struck centers 5 2 10 and 5-3 10
5-3-10																									0.131	0.138	0.165	0.169	0.091	0.118	
5-4-10																									0.138	0.143	0.167	0.172	0.091	0.123	Day after striking centers.
5-4-10	0.117	0.125	0.091	0.089	0.094	0.087	0.121	0.168	0.168	0.157	0.156	0.148	0.167	0.194	0.205	0.181	0.174	0.122	0.142	0.159	0.146	0.162	0.164	0.163	0.155	0.159	0.180	0.186	0.112	0.138	
5-4-10																										0.157	0.175	0.185	0.106	0.138	
5-5-10																									0.152	0.155	0.176	0.185	0.105	0.135	2 days after striking centers.
5 12-10													0.172	0.199	0.206	0.186	0.176	0.128	0.152	0.169	0.154	0.173	0.173	0.175	0.166	0.171	0.190	0.200	0.121	0.150	9 " " " "
5-16-10	0.133	0.146	0.111	0.110	0.116	0.104	0.125	0.188	0.188	0.169	0.169	0.158	0.180	0.206	0.214	0.194	0.186	0.138	0.161	0.183	0.165	0.181	0.181	0.182	0.172	0.176	0.196	0.205	0.128	0.157	13 " " " "
5-21-10	0.129			0.107				0.181			0.163			0.198	0.216	0.194			0.160	0.178	0.162	0.180	0.182	0.179	0.173	0.176	[illegible]	0.203	0.129	0.156	18 " " " "
5 26-10									0.188											0.175	0.159	0.174	0.178	0.177	0.172	0.175	0.196	0.203	0.124	0.155	23 " " " "
7-5-10																									0.206	0.214	0.231	0.241	0.173	0.198	Poured Columns [illegible] to 5-30-10 Grouted hinge plates [illegible] to 6-2-10 Poured spandrels 6-4-10 to 6-9-10 Laid floor slab 6-12-10 to 6-19-10
7-20-10																										0.216	0.237	0.243	0.170		

Note: Readings for all points below heavy horizontal lines were taken after these points were loaded.

The tabulated settlements of the arches are gross, that is, they include the settlements of the foundations also. To obtain (approximately only) the settlement of the arches with reference to the springing lines, it is necessary to deduct, from the readings of the arch settlement tabulation, the pier settlements of the nearest agreeing date



Integral figures indicate arbitrary reference points used to determine the settlement of the centering and arches. Figures written thus: 2/24, indicate the month and day on which the concrete blocks referred to were laid. Heavy black lines divide the arch ribs into the blocks of concrete built in a single day.

ciently set to permit of safely striking it. In some cases it might be well to see that columnar action had not developed to such extent as to buckle the first ribs, due to this inadvertent striking of the centers before the placing and setting up of the concrete diaphragms and sheeting.

Arch No. 1 was erected first, and then Arch No. 2, complete centering being furnished for both arches; then the falsework under Arch No. 1 was removed and set up for Arch No. 3. This was somewhat unprecedented, but it was done in order to save the contractor the expense of buying falsework for the third smaller arch. Care was taken, however, to watch Pier No. 1, which was founded on vertical piles, to see that there was no movement. Careful observation indicated that it did not move a measurable amount. This was partly due to the resistance of the concrete struts, which served to distribute the thrust of the arch throughout the piles of the entire system.

The falsework of Arches Nos. 2 and 3 was removed before the completion of Arch No. 4, similar observations being taken to make sure that there was no movement of Piers Nos. 2 and 3. It was planned to place vertical timber props under any arch from which the centering had been removed and adjacent to a pier showing movement, using the concrete struts as foundations to support the timber props. These props could have been placed in half a day, and they would have been just as efficient as the original centering.

Careful measurements, made at either end of the eighteen lead-covered hinge plates of the large arch, showed, upon striking, a change in the hinge opening of between $\frac{1}{32}$ and $\frac{1}{16}$ in. As there was no settlement of the abutment foundation, and only a reasonable settlement of Pier No. 3, the hinges were grouted and made solid prior to building the spandrel walls and columns. These hinges were designed so that the compressive stress in the concrete would not exceed 1 000 lb. per sq. in., even if the hinges were not grouted up until the bridge was complete. It was not intended to grout these hinges as long as there was any progressive settlement of the foundations. For concrete, this compressive stress, of 1 000 lb. per sq. in., is somewhat high, even when the area compressed is only one-third of the total area of the pressed surface, and therefore it was deemed advisable to reinforce with nails the concrete of the arches adjacent to the hinge and 2 ft. therefrom, measured along the axis of the arch. Tests made on nail concrete by the resident engineer, although not entirely satisfactory, due to the small size of the cubes, clearly indicated its efficiency. This efficiency had been demonstrated previously by the Bridge Department of the City of New York.

TABLE 1.—STRUT SHORTENING.

Transverse Line "A" Crossing Struts.

Date	1–13–10	5–1–10	5–5–10	5–12–10	7–21–10
West strut	0.0	0.0	$\frac{1}{8}$ in.	$\frac{1}{8}$ in.	$\frac{1}{4}$ in.
Middle strut	0.0	$\frac{1}{32}$ in.	$\frac{1}{16}$ in.	$\frac{1}{16}$ in.	$\frac{1}{8}$ in.
East strut	0.0	0.0	$\frac{1}{32}$ in.	$\frac{1}{32}$ in.	$\frac{5}{32}$ in.

Transverse Line "B" Crossing Struts.

Date	1–13–10	5–1–10	5–3–10	5–5–10	5–12–10	7–21–10
West strut	0.0	0.0	0.0	$\frac{3}{32}$ in.	$\frac{3}{32}$ in.	$\frac{3}{16}$ in.
Middle strut	0.0	$\frac{1}{16}$ in.	$\frac{1}{16}$ in.	$\frac{7}{32}$ in.	$\frac{7}{32}$ in.	$\frac{5}{16}$ in.
East strut	0.0	0.0	0.0	$\frac{3}{32}$ in.	$\frac{3}{32}$ in.	$\frac{3}{16}$ in.

Transverse Line "C" Crossing Struts.

Date	1–13–10	5–1–10	5–3–10	5–4–10	5–5–10	5–12–10	7–21–10
West strut	0.0	$\frac{1}{4}$ in.	$\frac{1}{4}$ in.	$\frac{5}{16}$ in.	$\frac{11}{32}$ in.	$\frac{15}{32}$ in.	$\frac{1}{2}$ in.
Middle strut	0.0	$\frac{1}{8}$ in.	$\frac{5}{16}$ in.	$\frac{5}{16}$ in.	$\frac{11}{32}$ in.	$\frac{11}{32}$ in.	$\frac{15}{32}$ in.
East strut	0.0	$\frac{3}{16}$ in.	$\frac{1}{4}$ in.	$\frac{5}{16}$ in.	$\frac{11}{32}$ in.	$\frac{11}{32}$ in.	$\frac{9}{16}$ in.

Before beginning work on the large arch, three transit lines at right angles to the axis of the arch were established across the concrete struts just south of Piers Nos. 3, 2, and 1. Table 1 gives the readings taken on these struts, and Table 2 shows the settlement of the piers under their loads. Plate CXXXVII shows the deformation of half of the large arch, including its centering, and the deformation of one of the small arches and its centering. The record for only one-half of Arch No. 4 is of interest, as the other was quite similar. A record of only one small arch is given, because the settlement of the others was almost identical.

Plate CXXXVII shows, in tabulated form, the deformation of the falsework under Arch No. 1, the settlement of this arch on the striking of the centering, and the further deformation of the arch after the striking of the centering and during and after the pouring of the columns, spandrels, and floor slabs. It also shows the order of constructing the arch, and the deformation at various times.

It should be noted that the settlement of the falsework under the concentrated loads of the arch-rib blocks was distributed by the sway

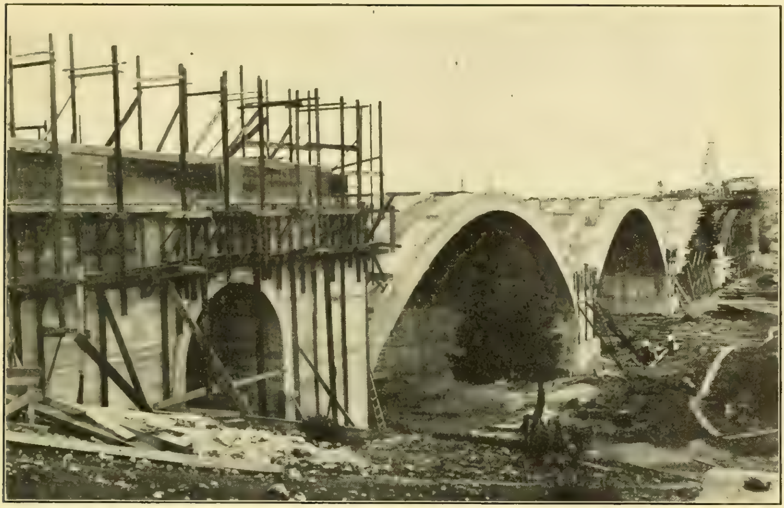


FIG. 1.—CENTERING REMOVED FROM ARCHES NOS. 1 AND 2. VIEW FROM POINT NEAR SOUTH ABUTMENT.

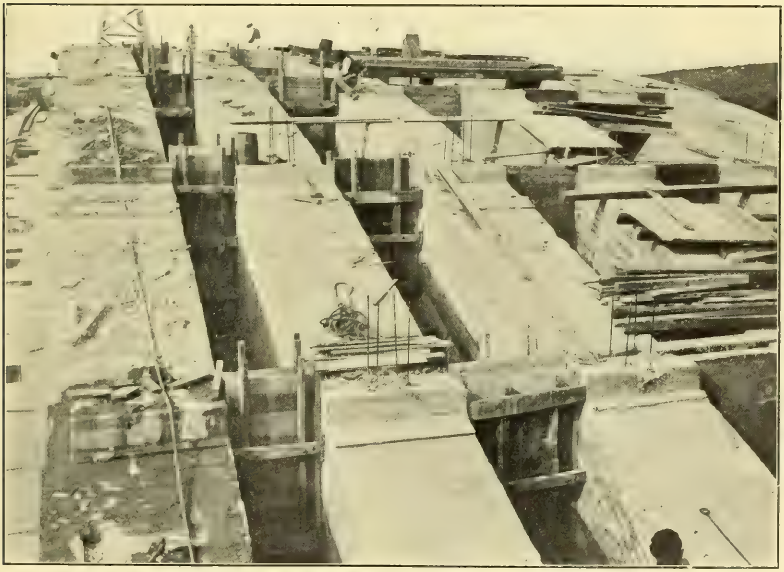


FIG. 2.—BACK OF 190-FT. ARCH.

PLATE CXXXIX.
PAPERS, AM. SOC. C. E.
SEPTEMBER, 1911.
KLAPP AND DOUGLAS ON
REINFORCED CONCRETE BRIDGE.

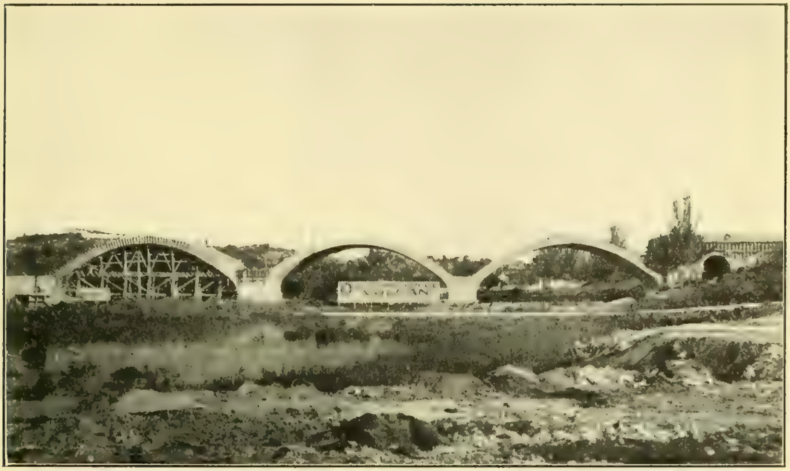


FIG. 1.—CENTERING REMOVED FROM ARCHES NOS. 1 AND 2.

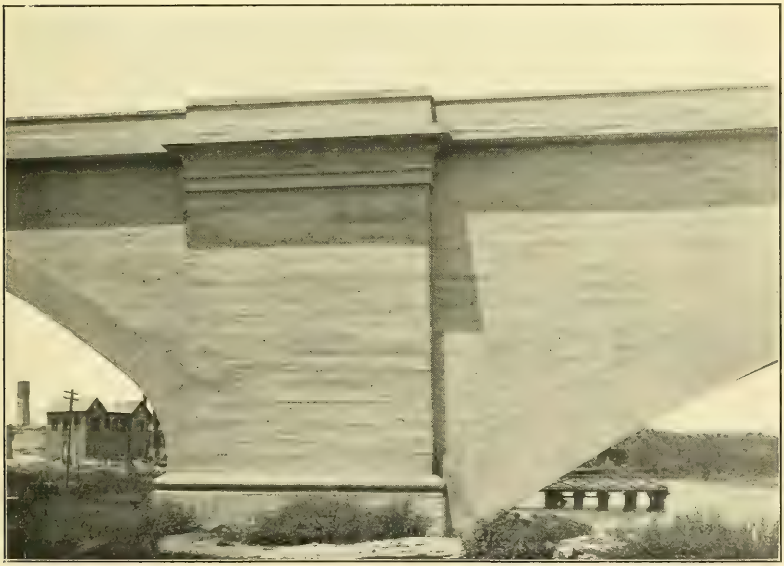


FIG. 2.—PIER NO. 3.

bracing. This is made evident by the fact (line 2 of the tabulation), that on July 4th, when Points 1, 3, 7, and 9 were only one-half loaded, whereas the other points were fully loaded with the arch-rib load, the settlement under the half-loaded points was almost as great as that under those fully loaded.

After the arch ribs were completed, and before the centers were struck, the additional settlement of the falsework was very small, being between ⅛ and ¼ in. After the centers were struck there was no further settlement of the arch ribs. The centering under Arch No. 1 was struck before the adjacent arch was built, and the survey records show that the striking of the centers did not move Pier No. 1, and this is further demonstrated by the fact that there was no lowering of the crown of Arch No. 1 when the centering was struck.

The total deformation of the falsework was about 1⅛ in. This allows for approximately $\frac{1}{16}$ in. for take-up of the horizontal joints of the falsework, $\frac{1}{16}$ in. for the bite of the end grain on the side grain, and the remainder was due to the shortening of the piles under their load.

It should be noted that the arch settlements tabulated on Plate CXXXVII are gross, that is, they include also the pier settlements.

When the other arches were struck there was a tendency of the crown of Arch No. 1 to rise, on account of the thrust of Arch No. 2 against it, and on account of the unbalanced horizontal thrust from Arch No. 4, acting through the three horizontal struts which were designed to transmit this unbalanced thrust to rock.

It will be noted later that Pier No. 1 moved horizontally between ⅛ and ¼ in., due to the thrust of the large Arch No. 4, but the tendency of Arch No. 1 to rise on account of this movement seems to have been counterbalanced to a large degree by the settlement of the adjacent piers and the shortening of the arch ribs under the axial thrust of the added load of spandrels and floor slab.

Plate CXXXVII also shows the deformation of the falsework of Arch No. 4 and of the arch ribs. The tabulation for Arch No. 4 also shows, more clearly than that for Arch No. 1, the fact that the concentrated loads of the individual arch blocks were distributed through the sway bracing, so that points a considerable distance from those loaded show decided settlement. In other words, it shows that the load was transferred through the bracing into the pile foundations. For instance, note the second line of the tabulation for Arch

TABLE 2.—PIER

Date.	PIER No. 1.				PIER No. 2.				PIER No. 3.			
	23	24	25	26	48	49	50	51	73	74	75	76
7-5-09...	0.009	+0.003	0.003	+0.002	+0.009	+0.009	0.004	0.002	0.004	0.000	0.006	0.013
8-8......	+0.003	+0.015	0.006	0.000	+0.013	+0.011	0.014	0.007	+0.003	+0.008	0.002	......
8-14.....	+0.001	+0.003	0.007	0.004	+0.008	+0.005	0.013	0.011	....	....	......	......
10-1.....	0.018	0.000	+0.008	+0.006	+0.012	+0.004	0.003	0.001	+0.003	0.002	0.002	0.015
1-21-10..	0.014	....	....	0.015	0.012	0.015	0.030	......	....	....	.....	......
1-22.....	+0.012	0.001	0.014	0.011	0.010	0.010	0.030	0.033	0.006	0.011	0.026	0.037
1-26.....	......	....	....	....	0.015	....	0.034	......	......	....	0.022	0.027
1-26.....	....	....	....	....	....	....	0.032	0.033	......	....	0.024	0.028
2-21.....	0.013	0.011	0.023	0.021	0.017	0.019	0.036	0.032	0.013	0.014	0.035	0.030
3-7......	0.007	0.009	0.016	0.011	0.015	0.009	0.031	0.027	0.018	0.033	0.043	0.043
3-18.....	0.007	0.000	0.016	0.008	0.010	0.013	0.029	0.024	......	....	......	......
4-12.....	0.017	0.016	0.031	0.019	0.022	0.028	0.043	0.039	0.020	0.043	0.046	0.051
4-23.....	0.010	0.014	0.015	0.013	0.025	0.019	0.036	0.029	0.028	0.040	0.035	0.050
5-1......	0.016	0.021	0.034	0.032	0.028	0.027	0.053	0.045	0.026	0.041	0.047	0.050
5-3......	....	....	....	....	....	0.021	0.041	0.038	0.024	....	0.044	0.054
5-4......	0.022	0.029	0.015	0.022	0.023	0.039	0.039	0.036	0.030	0.072	0.053	0.060
5-5......	0.015	0.021	0.024	0.023	0.029	0.026	0.049	0.037	0.030	0.051	0.053	0.063
5-12.....	0.011	0.020	0.019	0.019	0.030	0.030	0.039	0.036	0.040	0.060	0.055	0.063
5-26.....	0.011	0.020	0.033	0.032	0.032	0.033	0.057	0.055	0.030	0.052	0.061	0.071
7-5......	....	....	.... ..	....	....	....	......	......	0.057	0.080	0.083	0.102
7-20.....	0.021	0.031	0.036	0.035	0.044	0.048	0.075	0.071	0.049	0.080	0.082	0.102
7-21.....	0.022	0.029	0.034	0.036	0.048	0.047	0.075	0.072	0.051	0.077	0.083	0.101

+ Readings indicating a rise of pier are evidently incorrect, as are those showing

No. 4, under date of 2-12-10. This shows that at that time only Points 5, 7, 29, 41, and 53 were loaded, yet nearly all the other points show depression, and, in some cases, as Point 3, it is as great as at the loaded points (Points 5 and 7) in its vicinity. This condition is found throughout the tabulation.

It should be noted that on the date of completing the arch ribs, 3-25-10, the maximum settlement at any point was slightly less than 2 in. and the average about 1¼ in. As the loading of the diaphragms and sheeting was continued, the deformation increased very slightly.

On May 3d, 1910, the centers were struck. There was a considerable lowering of the crown immediately on the striking of the cen-

SETTLEMENTS.

Remarks.			
Arch No. 1.	Arch No. 2.	Arch No. 3.	Arch No. 4.
2 ribs completed, 7-3-09. Arch completed, 7-28-09.			
....	2 ribs completed, 8-14-09. Arch completed, 8-17-09.		
Struck centers, 9-29-09.			
....	Struck centers, 11-25-09.	2 ribs completed, 11-8-09. Arch completed, 11-10-09.	
....	....	....	2 ribs completed, 2-20-10.
....	....	Struck centers, 3-8-10.	
Poured spandrels, 4-7-10.	....	....	Arch completed, 3-26-10.
....	Poured spandrels, 4-19-10.		
Poured floor slab, 4-26-10.	....	Poured spandrels, 4-30-10.	
....	....	....	Struck centers, 5-3-10.
....	Poured floor slab, 5-16-10.	Poured floor slab, 5-24-10.	
....	....	....	Poured spandrels, 6-9-10. Poured floor slab, 6-19-10.

apparent temporary rises. All settlements are expressed in decimals of a foot.

tering. This amounted to as much as ⅜ in., and progressed until the last recorded date, 7-20-10, at which time the bridge was complete, the changes, however, being negligible between 7-5-10 and 7-20-10. The large arch settled more than Arch No. 1, when struck, due to a number of conditions: (1) its greater span; (2) the fact that it was built in a great number of transverse blocks and that between the adjacent concrete blocks there were hair-thin shrinkage cracks; and (3) that the entire horizontal arch thrust of this large arch was carried through the horizontal concrete struts, causing them to shorten, and the shortening of these struts caused the crown and, in fact, the entire arch rib, to lower.

It will be seen from Table 1 that the shortening of the struts went on progressively also, and, therefore, had material bearing on the lowering of the large arch rib.

In the tabulation for Arch No. 1, and also for Arch No. 4 (Plate CXXXVII), there are many irregularities in reading, in some cases indicating that the arch went up and down at intervals. It is necessary, therefore, to disregard small differences, which are evidently errors of measurement.

The pier tabulation (Table 2) shows the progressive settlement of all piers. As stated previously, these piers were built on pile foundations, the length of the piles in Pier No. 1 averaging 56 ft. and those in Piers Nos. 2 and 3 averaging 60 and 45 ft., respectively. The general settlement of these piers under their loads was rationally progressive. The four corners of Pier No. 1 settled almost uniformly, whereas Pier No. 2 settled about ⅜ in. more on the east side than on the west, and Pier No. 3 settled ⅝ in. more at the northeast corner, Point 76, than at the southwest corner, Point 73. In the case of Pier No. 3, Point 76, the deformation exceeded the theoretic shortening of the piles by about ½ in. It is a matter of conjecture rather than fact whether this settlement was due to any bruising of the piles or to the nosing of their ends into the uneven coral foundation rock.

By noting the dates on which the various ribs and arches were completed, and those when the arches were struck, and other dates contained in the column headed "Remarks," the progressive settlement of the piers will be seen to follow, in a general way, the loads which came on them. Arch No. 1, however, which was struck on 9-29-09, did not seem to affect Pier No. 1 very much, as may be seen by the readings for that pier marked 8-14-09 and 10-1-09. However, after Arch No. 2 was struck (on 11-25-09) as shown by the reading of 2-21-10, the settlement had reached about ¼ in.

Pier No. 2 did not show any settlement until after Arch No. 2 was struck. The reading of 1-21-10 shows a settlement of about ¼ in. When Arch No. 3 was struck, on 3-8-10, there was no additional settlement (see reading on 3-18-10); but, as the work was built up, the settlement progressed until at completion it was between ⅝ and ⅞ in.

Arch No. 4 was begun on 2-8-10 and Pier No. 3 showed considerable settlement when two of its ribs had been completed (as indicated by the reading on 2-21-10). At that time the west side of the pier had settled a little more than ⅛ in. and the east side about ⅜ in. When

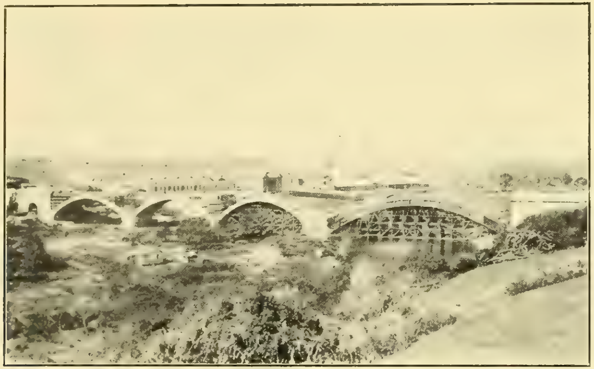


FIG. 1.—ARCHES NOS. 1, 2, AND 3, WITH CENTERING STRUCK.

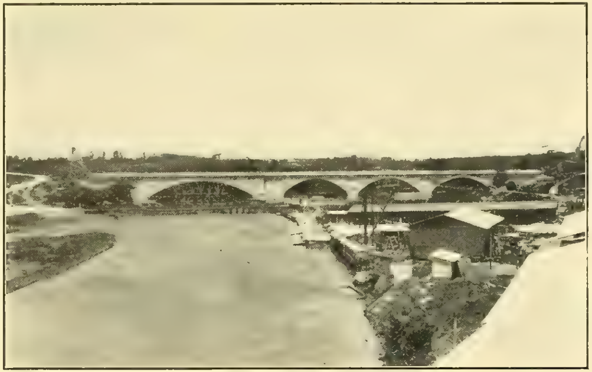


FIG. 2.—COMPLETED BRIDGE.

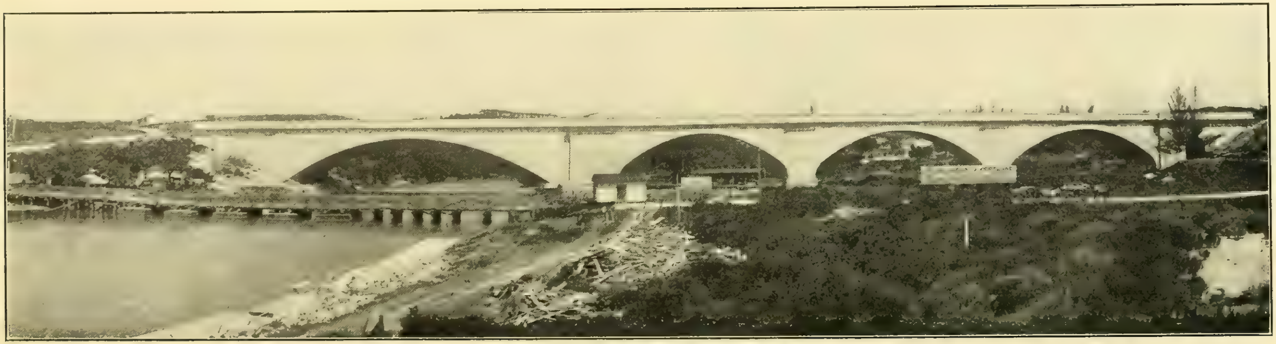


FIG. 3.—COMPLETED BRIDGE.

Arch No. 4 was completed the readings on 3-18-10 and 4-12-10 indicate that there was a slight change, showing that this large arch was developing arch action though still on its falsework. After the keying of the arch, there was no further settlement of Pier No. 3 until the center was struck, as shown by the readings from 5-3-10 to the end of the tabulation. It should be noted that the settlement of these piers was gradual, covering a period of a little more than two months, during which time the loads of the columns, spandrels, and floor slab had been added.

Table 1 shows at various times the shortening of the struts under the thrust of the large arch. It should be noted, from Line "C," that the shortening of the struts at the point "C", before striking the centering of Arch No. 4, was about $\frac{3}{16}$ in., and when the striking of the centering was completed, this had increased to $\frac{5}{16}$ in. Two days afterward it was $\frac{11}{32}$ in., and on the completion of the work it was a little more than $\frac{1}{2}$ in. Assuming the coefficient of elasticity of the concrete at 1 000 000, the total horizontal thrust carried by the struts is approximately 1 800 000 lb. The total horizontal thrust was 5 600 000 lb., leaving 3 800 000 lb. to be taken by the piles, or 7 200 lb. per pile. It is thought that the ground near the piles was able to take such a portion of the total thrust.

It is seen that at Line "B" there was no measurable shortening until after the large arch was struck, in which case the middle strut had shortened $\frac{7}{32}$ in., and the outer struts $\frac{3}{32}$ in. This increased until, on the completion of the work, the middle strut had shortened $\frac{5}{16}$ in. and the outside struts $\frac{3}{16}$ in. A similar shortening is found at Line "A." On the completion of the arches, the shortening of the outside struts was $\frac{1}{4}$ in. and that of the middle strut was $\frac{1}{8}$ in. From Table 1 it appears that Pier No. 1 moved approximately $\frac{1}{8}$ in., Pier No. 2 about $\frac{1}{4}$ in., and Pier No. 3 about $\frac{1}{2}$ in.

As American engineers are doing an increasing amount of concrete work in Cuba and other tropical countries, the unit prices, Table 3, paid to the Contractors, Champion and Pascual, of Havana, are thought to be of interest. The work was let to the lowest bidder, and, as far as the writers have been able to ascertain, these prices were such as to ensure a reasonable profit. They are further of the opinion that the contract cost of similar work executed in the United States, where common labor is based on a 10-hour day and receives, say, $1.50, and carpenters on form work an average of $3, would be about eight-tenths of the cost in Havana.

TABLE 3.—Unit Prices Paid to the Contractors.

Excavation	Cubic yards	$1.54	8 950	$13 783.00
Piles	Feet	1.52	36 000	54 720.00
Concrete	Cubic yards	9.80	12 820	125 636.00
Steel	Pounds	0.035	390 162	13 655.00
Steel pipe, 10 in. in diameter	Pounds	0.10	6 130	613.00
Drain trap	Each	6.00	44	264.00
Cast-iron piping, 4 and 6 in.	Linear feet	1.22	1 200	1 464.00
Cast-iron piping, 8 in.	Linear feet	1.83	328	600.24
Cast-iron piping, 10 in.	Linear feet	3.05	52	158.60
Manholes	Each	14.00	10	140.00
Hand-grips	Each	0.50	349	174.50
Tar-paper	Square feet	0.07	5 000	350.00
Damp-proofing	Square feet	0.047	14 500	681.00
Hand-holes	Each	13.80	18	248.40
Bore-holes, North abutment	Linear feet		300	1 593.90
Change in concrete				1 078.13
Extra expansion joints, North approach				32.86
Hinge plates	Square feet		180	1 558.55
Base mouldings	Linear feet		576	1 000.00
				$217 751.18

Cost of bridge floor, $6.50 per sq. ft.

In conclusion, the writers wish to call particular attention to the interesting problems involved in carrying a massive structure on generally compressible foundations, and where a large unbalanced horizontal thrust required a special expedient to overcome the insufficiency of the normal pile foundation to resist such a thrust. They wish, however, to make clear that the undesirable condition of caring for the unbalanced horizontal thrust, which might readily have been overcome by arches of equal span, was one which it was not in their power to change.

The bridge was designed by, and constructed under the direction of, the firm of Barclay Parsons and Klapp, of which the writers are members. The pile foundations were placed under the supervision of the firm's representative, Mr. E. F. Saxton. The remainder of the work was built under the supervision of Gratz B. Strickler, M. Am. Soc. C. E., as Resident Engineer, to whom much credit must be given for its satisfactory execution and for the complete records of the arch construction.

The plans for the bridge were made and the work carried on with the co-operation of General Ernesto Asbert, Governor of the Province of Havana, and Mr. Francisco Franquiz, Director of Public Works.

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AMERICAN SOCIETY OF CIVIL ENGINEERS

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PAPERS AND DISCUSSIONS

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A REINFORCED CONCRETE STAND-PIPE.

By W. W. Clifford, Jun. Am. Soc. C. E.

To be Presented November 15th, 1911.

The reinforced concrete stand-pipe built at Westerly, R. I., during the summer of 1910 for the town water-works, is of interest because of some methods of construction which were used for the first time, and also because, in appearance and water-tightness, it is one of the most successful ever built.

Westerly is a town of about 9 000 inhabitants. Its water supply is derived from driven wells and distributed by pumping. Prior to 1911 the only reserve supply was contained in a steel stand-pipe having a capacity of 370 000 gal. Additional reserve was thought advisable, and, as the old stand-pipe needed a thorough overhauling, it was decided to build a new one on Quarry Hill, very near the old one. Concrete was chosen as the material, in preference to steel, after the Water Commissioners had examined other concrete stand-pipes in New England.

The general shape of this stand-pipe is shown by Fig. 1, and Plate CXLI. The cement seemed to give the concrete a somewhat lighter color

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Note.—These papers are issued before the date set for presentation and discussion. Correspondence is invited from those who cannot be present at the meeting, and may be sent by mail to the Secretary. Discussion, either oral or written, will be published in a subsequent number of *Proceedings*, and, when finally closed, the papers, with discussion in full, will be published in *Transactions*.

In the *Proceedings* of this Society, the Papers and the Discussions on Papers will hereafter be printed so that each will commence on an odd-numbered page. This is done by special request, in order to enable members who wish to do so to separate the Papers and Discussions for filing under various engineering subjects.

than usual, and this was increased by the lime which was added, the result being an almost white concrete. As steel forms were used, its surface was very smooth. The jointing seen in Plate CXLI is due to the fact that the forms were not absolutely water-proof at the joints, and the water running out caused a slight burr at the edge of each panel. The finishing tiles of the dome are dark red and glazed, and, forming a marked contrast with the light concrete, give a distinctly pleasing appearance.

The stand-pipe is founded on hardpan, which at this point is only 5 or 6 ft. below the surface. The inside diameter is 40 ft.; the height, from the floor to the overflow, is 70 ft., and from the ground to the top of the ventilator on the dome, is about 88 ft. The thickness of the wall at the floor is 4 ft., tapers to 14 in. at a height of 5 ft., and is of this thickness up to the water line. The wall, for the first 5 ft. above the ground, has an outside diameter of 44 ft. 4 in., then an ornamental moulding reduces it to 42 ft. 4 in., which is constant to the bottom of the triglyphs, 6 ft. below the water line. Just above this there is a fillet 6 in. deep and projecting 4 in. Above the water line there is a cornice 24 in. deep and projecting 30 in. This is surmounted by a parapet wall 4 ft. high. A Guastavino dome of red tile springs from a seat 2 ft. above the water line. Its diameter is 41 ft. and its rise 13 ft.

A steel ladder, 1 ft. wide, of ½ by 1½-in. flats and ¾-in. rounds, is secured by bronze bolts in cast-iron sockets with 1-in. bronze faces, set into the wall at 16-ft. intervals. The rungs are 12-in. from center to center, but this spacing is reduced to 6 in. through the opening in the cornice. The ladder was erected in 16-ft. sections, and the bottom is about 16 ft. from the ground. Over the parapet the the flats are replaced by 1½ by 2½ by ¼-in. angles.

For construction purposes, a frame tower, large enough for a 1-yd. Ransome auto dump bucket, was placed so that it cleared the outside edge of the cornice by about 1 ft. This tower had 6 by 6-in. uprights, and was thoroughly cross-braced. A No. 2 Smith concrete mixer, run by steam, was set in a pit so that the materials could be conveniently dumped into the hopper from the ground. The mixer emptied directly into the bucket, which was run by a hoisting engine. The same boiler furnished steam for mixing, hoisting, and later, also, for pumping water to the top of the wall for washing it. The con-

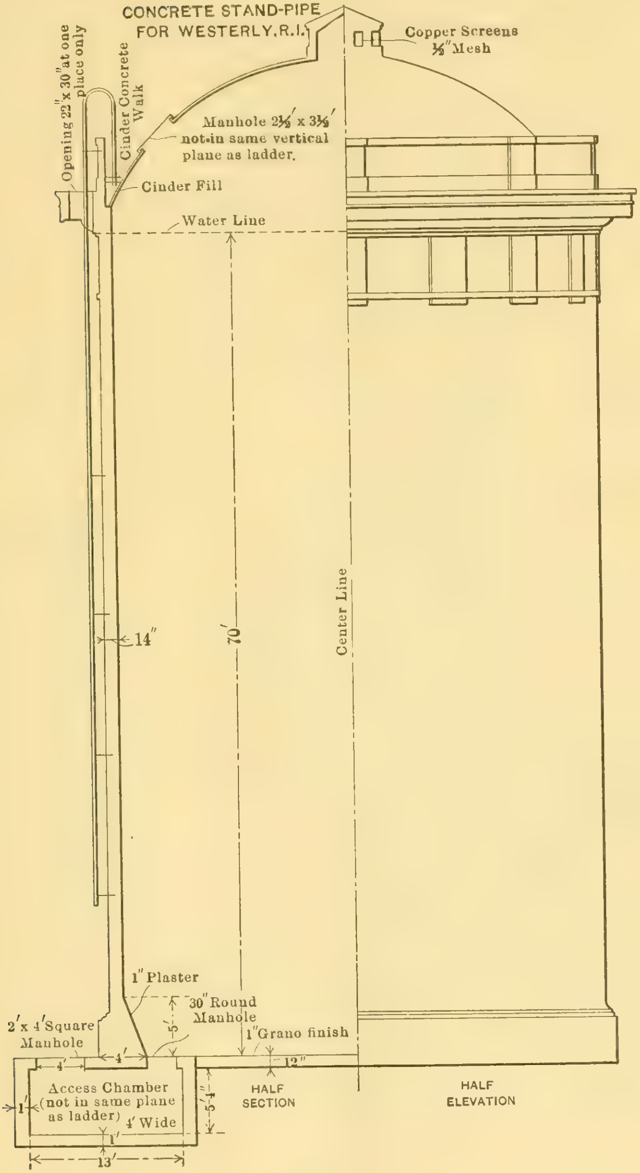

CONCRETE STAND-PIPE
FOR WESTERLY, R.I.
Copper Screens
½″ Mesh
Opening 22″ x 30″ at one place only
Cinder Concrete Walk
Manhole 2½′ x 3½′
not in same vertical
plane as ladder.
Cinder Fill
Water Line
14″
70′
Center Line
1″ Plaster
30″ Round
Manhole
5′
2′ x 4′ Square
Manhole
4′
4′
1″ Grano finish
12″
Access Chamber
(not in same plane
as ladder)
4′ Wide
1′
1′
5′-4″
13′
HALF
SECTION
HALF
ELEVATION

Fig. 1.

crete for the foundation floor and base was hoisted about 20 ft. and dropped in a chute; one section of this chute carried the concrete from the tower to the center of the tank, and from there a movable section delivered it in place.

An inside stage, Fig. 2, was used for all but the first few feet of the wall. The floor of this stage was framed of two rings of 8-in., 11¼-lb. channels. These rings were 38 and 28 ft. in diameter, respectively, and were in four sections, bolted together with standard splice-plates, the splices being staggered on the two rings. Two braces, each consisting of two 6¼-in., 5-lb. channels, held parallel and 18 in. apart by bolts passing through pipe spacers, were placed diametrically across the inside of the inner ring at right angles to each other.

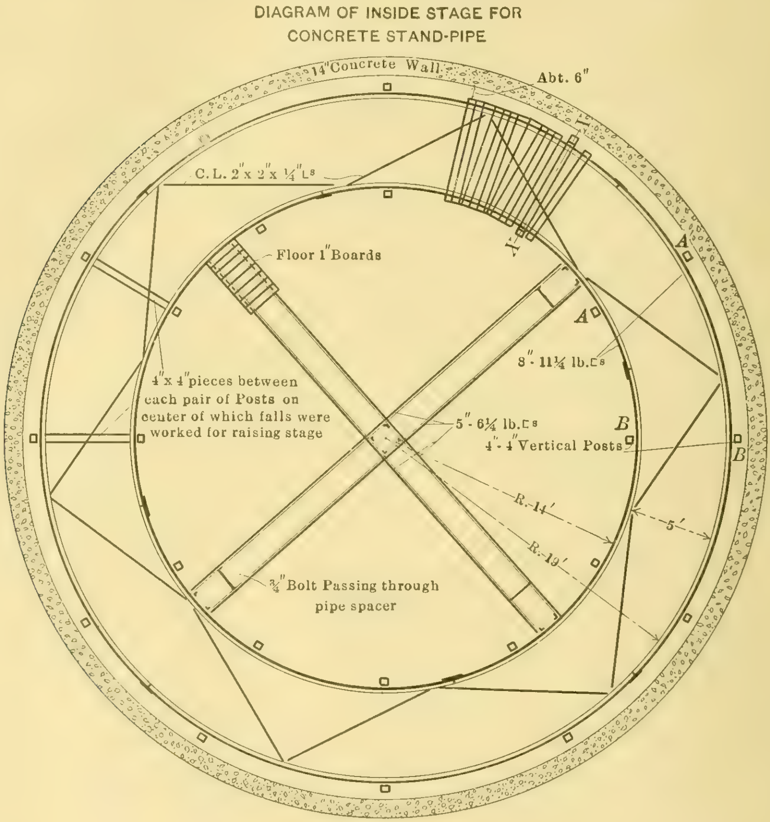
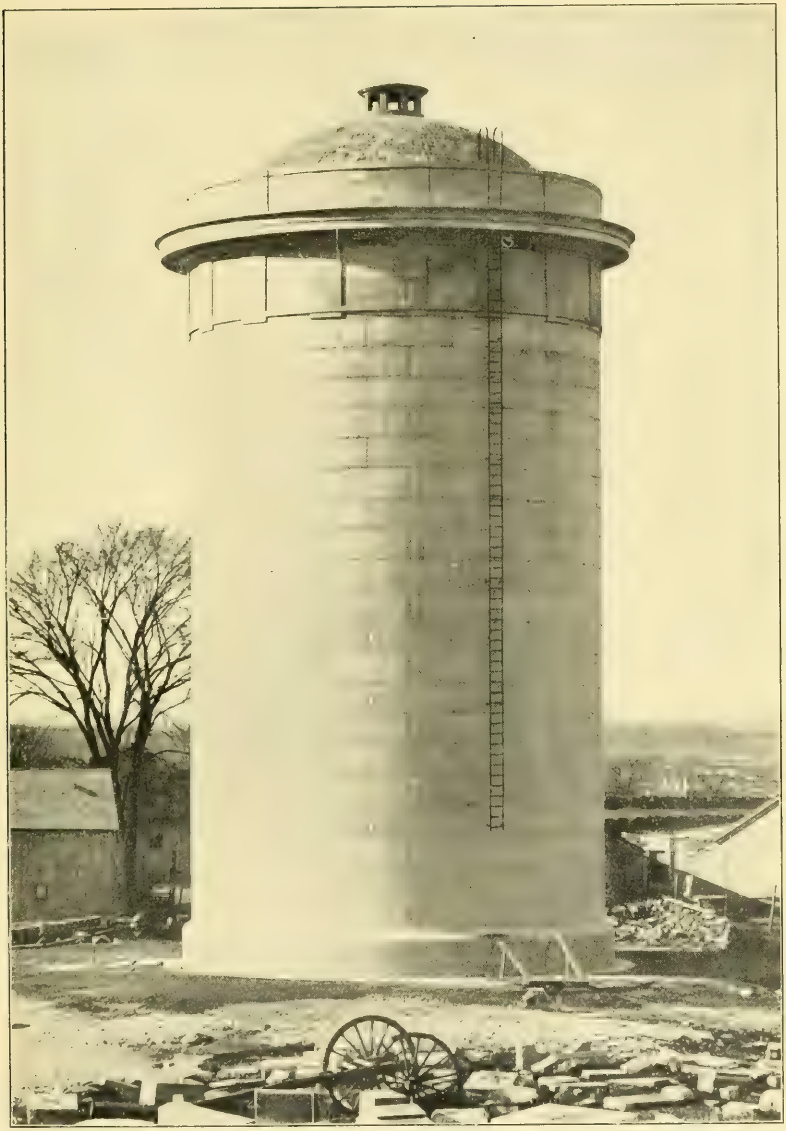


DIAGRAM OF INSIDE STAGE FOR
CONCRETE STAND-PIPE
14" Concrete Wall
Abt. 6"
C. L. 2" x 2" x ¼" Ls
Floor 1" Boards
A
A
8" - 11¼ lb. ⊏s
4" x 4" pieces between each pair of Posts on center of which falls were worked for raising stage
5" - 6¼ lb. ⊏s
B
4" - 4" Vertical Posts
B
R.-14'
5'
R.-19'
¾" Bolt Passing through pipe spacer

Fig. 2.

PLATE CXLI.
PAPERS, AM. SOC. C. E.
SEPTEMBER, 1911.
CLIFFORD ON
REINFORCED CONCRETE STAND-PIPE.



REINFORCED CONCRETE STAND-PIPE AT WESTERLY, R. I.

There was a lattice bracing of single 2 by 2 by ¼-in. channels between the curved channels. The upper flanges of the curved channels were bored every 3 ft. to receive the bolts for the nailing strips. Planks, 2 in. thick and 6 ft. long, were nailed on the curved channels, making a solid floor of this width which cleared the inside of the wall by 6 in., and was very rigid and satisfactory. A floor of boards, 2 ft. wide, ran across one pair of diametrical channels, and on this was stored wheel-barrows, and other tools when not in use. The uprights for this stage were 4 by 4-in. spruce posts, spaced as shown in Fig. 2. Ledges, composed of two 1 by 6-in. boards, were nailed on each pair of uprights, and the 8-in. channels rested on these. The outside posts went down vertically to the point where the wall commenced to flare in, and there they also bent toward the center and rested on the bottom close to the wall. The bottoms were braced apart by horizontal, radial struts, and the inside posts were all diagonally braced in radial planes down to these struts. Lattice bracing was put in the planes *AA′*, *BB′*, etc., in 3-ft. panels, or for each lift of the stage, and in the planes *AB*, *A′B′*, *BC*, *B′C′*, etc., in 6-ft. panels, or for each alternate lift of the stage. All the bracing was of 1-in. spruce boards, 6 in. wide. The posts, in 16-ft. lengths, were kept ahead of the stage, and a 4 by 6-in. cross-head was put across the top of each pair, the

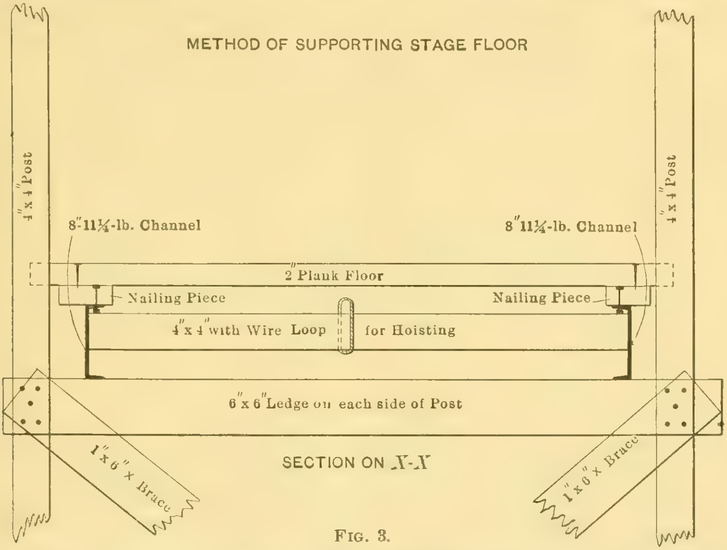


FIG. 3.

inner end at the inner posts, and the other end projecting 2 ft. beyond the outer posts. This cross-head had a wire hook half way between the posts, and there was a corresponding hook at the middle of a 4 by 4-in. piece parallel to the ledges, and wedged in between the 8-in. channels radially.

When the stage was to be raised, eight 2 000-lb. differential chain falls were hooked into these loops, and, with two men on each, the stage was raised in a few moments, the whole floor moving as a unit. When the proper height was reached, new ledges were put on, and bracing below if necessary, and the stage was ready to use. The concrete, hoisted in the bucket, was dumped into a hopper hung on the face of the construction tower about 3 ft. above the stage; a platform 6 ft. wide was laid down between the stage and the tower, over the top of the wall. The wheel-barrows received their load from a gate in the bottom of the hopper, and were wheeled around and dumped directly into the forms, the stage during the pouring being flush with the top of the form which was being filled.

The forms for the outside of the base were of wood with 2 by 8-in. horizontal ribs and ⅞-in. vertical laggings. These forms, and also the soft pine moulding forms, were made in a local lumber yard. The forms for the inside of the base were made at the site, and were in short chords instead of arcs.

Steel forms were used successfully for all plain wall. They were made in panels about 3 ft. deep, and 8 ft. long. The exact depth was one-twentieth of the distance from the top of the moulding at the base to the under side of the triglyphs. Each panel was of ⅛-in. plate with 1½ by 1½ by ⅛-in. angles riveted on the edge, the back of the angle being toward the edge of the plate. They also had two vertical stiffener angles. The angles on the edge were bored to receive the bolts which held the panels together and kept one set in place on top of the other. The panels were of such a size that they could be handled easily by two men, and two complete sets were used.

When the steel forms were placed on those of the base, the inside ring was about half a lift higher than the outside at first, as may be seen from the section, Fig. 1. This was overcome on the third lift by moving both inside forms up together until they were flush with the outside ones. A turnbuckle had been put in over a slip joint at one place on each ring of the inside forms, in order to loosen the whole

PLATE CXLII.
PAPERS, AM. SOC. C. E.
SEPTEMBER, 1911.
CLIFFORD ON
REINFORCED CONCRETE STAND-PIPE.

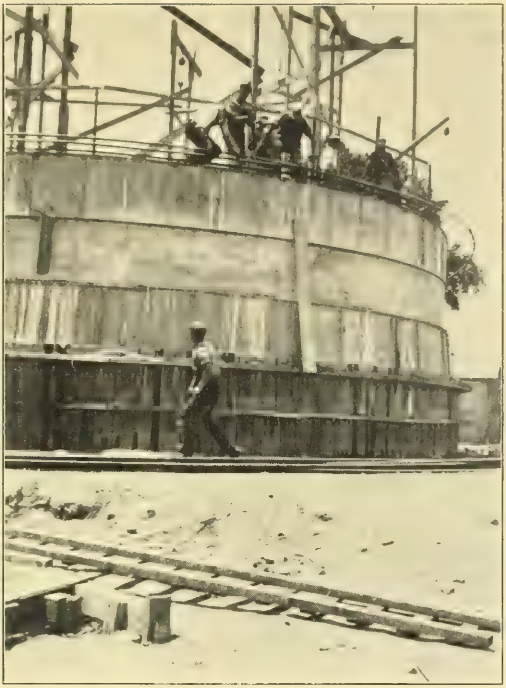


FIG. 1.—FORMS FOR CONCRETE STAND-PIPE IN POSITION. ERECTING REINFORCING BARS.

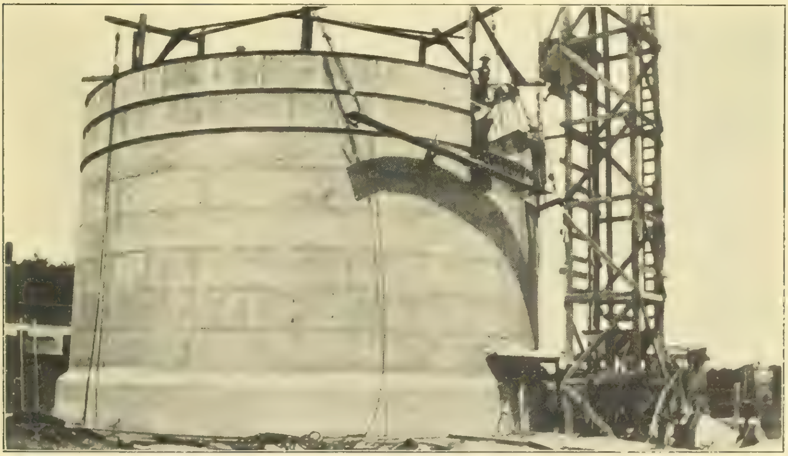


FIG. 2.—SETTING STEEL FORMS FOR CONCRETE STAND-PIPE.

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form at once; but it was found so difficult to spring these forms back that this method was not used again. Swinging stages were hung from the projecting ends of the cross-heads at the top of the staging posts, and men working on these unbolted the lower set of outside forms when they were to be moved up. Ropes were lowered from the stage and hooked into the panels before the last bolts were removed. The forms were then hauled up on the stage, cleaned, greased, and bolted in place on the other set.

The inside forms were handled in a similar way, except that the men operated from the bracing of the inside stage. These forms were a little too light, and caused some trouble by springing out of shape. This made the constant use of drift-pins necessary, to line up the bolt holes. The bolts were subjected to such rough treatment that they could be used on the average only twice. Toward the latter part of the work short boards were nailed on the floor of the stage, in 12 or 15 places around the circumference, to hold the inside form out to the proper radius. Spreaders and wire ties were then put between the tops of the forms at these places. The bottom was held by the form already filled. This method held the forms firmly in place, and took very little time, not more than an hour for three men.

Pieces of 2-in. plank cut radially were bolted under the top flange of the twentieth form, and supported wooden forms for the lower ends of the triglyphs and the fillet. Both steel forms were set up on the fillet, with spacers between the panels to spread them to the outside diameter of the triglyphs. Through holes bored in the steel forms nailing strips were bolted, and vertical lagging was nailed to these, to make boxes for the indentions between triglyphs. The pieces of plank which had supported the fillet forms were again bolted under the top flange of the forms, and supported wooden forms for the short section of walls between the top of the triglyphs and the bottom of the cornice.

The plans called for overflow holes, 12 in. wide and 3 in. deep, spaced 45° apart around the circumference, but as these openings provided the only opportunity to support the cornice forms, they were spaced $11\frac{1}{4}$° apart, and the extra ones were filled up afterward. One day's pouring was ended at the top of these openings, and flat concrete blocks were placed over them and incorporated in the wall, in order to obviate the difficulty of removing forms from such small openings. Pieces of 4 by 4-in., 6 ft. long, were cut down to 3 by 4 in. for 18 in. at one end, and two were put in each overflow hole, making as great an angle as possible with each other. The outer ends of these brackets were braced down to the fillet 6 ft. below. On these 64 brackets the cornice forms were built, partly of lumber sawed in the yard and partly of plaster of Paris on metal lath which was used so that the concrete would not be damaged by the swelling of the wood when wet. The plaster was composed of equal parts of plaster of Paris and Limoid. It was placed and shaped by trowel and template, and smoothed with a 4-in. paint brush and water while still green.

The outside base forms, with boxes built inside to give the proper shape, were used in building the parapet. The inside steel forms were used from the top of the base to the top of the parapet, spreaders being put between the panels above the dome seat. For carrying up the center, short vertical planks were bolted into four sockets inside the wall. These were set at the same height and equally spaced. To the tops of these planks two wires were fastened so as to stretch diametrically across the tank. By revolving the planks slightly about the bolts, the wires were adjusted so that their intersection was exactly at the center. This arrangement was put in every 15 or 20 ft., for the tank was filled as the work progressed.

The centers for the dome were supported by the inside stage, which was left in for that purpose, and later all the long pieces were taken out through a manhole in the dome by a gin pole placed on the cornice. The smaller pieces were taken out through the access chamber.

The main reinforcement was of plain, round, mild-steel bars, 1½ and 1⅛ in. in diameter. These bars were 71 and 69 ft. long, so that two formed a complete ring, allowing 40 diameters for lap. The bars were bent on the ground, by from 4 to 6 men, blocks being set by trial to give the necessary curvature. They were then hammered to set. They were hoisted by two No. 0 Parker derricks, and, in addition, it was found necessary to use one of the swinging stage falls on the middle of the bar. On arriving at the top of the wall, they were taken to their position by hand. These hoops were supported by twelve equally spaced 1½-in. vertical iron pipes, resting on standard 6-in. flanges on the floor. These pipes were in 3-ft. sections, corresponding to the height of a form. The sections were joined by ordinary couplings, and erected as the work progressed. Braces of 2 by 2 by ¼-in. angle iron connected these pipes while the steel was being put on. These were bolted into special castings screwed into the couplings on top of the last erected sections of pipe, and were removed when the steel was in place and another section of pipe was to be erected. Radial ¼-in. holes were bored through these pipes at the proper intervals for the rods, and through these holes were put ¼-in. hooks, in which the rods were placed. The hooks were then hammered flat against the pipe or around the bar. In some cases it was found necessary to use some No. 10 wire, as well as the hooks, to fasten the rods to the pipes. The pipes were filled with grout as the work progressed. The joints were staggered so that about one in twelve came in the same vertical plane. Two Crosby clips, such as are commonly used for guy wire, were also used on each joint.

In the floor the secondary reinforcement is composed of ¼-in. square rods, 6 in. from center to center both ways. The rods are 1 in. below the surface, and are bent up 4 ft. into the wall. Around the manhole and the access chamber in the roof, ⅝-in. round and 1¼-in. square rods are used. Just under the dome seat there are ¼-in. square rods, set horizontally, and ⅝-in. round rods, 4 ft. from center to center, are bent out into the cornice. Round ⅝-in. rods, 7 ft. long and 2 ft. from center to center, run vertically up into the parapet.

The proportions for the concrete were decided after numerous carefully made experiments, for dependence was placed on the density of the concrete to make it impervious.* The materials available were crushed granite and several bank sands, all of good quality. Vulcanite cement was used. The granite (gray Westerly) was a satisfactory larger aggregate. The sand chosen was that which contained the least vegetable matter and showed the greatest percentage of strength. Samples of sand and of stone were sifted through a set of sieves, in order to ascertain the percentage by weight retained on each sieve. From these data curves were plotted, using the percentages passing through the sieves as ordinates and the sizes of the sieves as abscissas. The sand (Curve *A*, Fig. 4) ranged from 1½-in. gravel down to grains passing through a 100-mesh sieve. The stone (Curve *B*, Fig. 4), which was supposed to be crusher-run below 1½-in. with the dust screened out, ranged from that size down to a little very fine dust which was carried over the screen by the larger pieces. Then a curve was plotted which, according to the experiments by Messrs. Taylor and Thompson, represented a mixture of sand and broken stone of maximum density. This is shown on Fig. 5. The mixture of the available sand and stone which gave a curve nearest to this ideal was calculated (Curve *C,* Fig. 5). From the calculations and the shape of the original curves, it was seen that the materials could not be combined to produce a curve in which the maximum deviation from the ideal curve was less than 6 or 7%, that is, they could not be combined to form a curve of this shape, but it was plainly seen that if the finer stone or the coarser sand was removed, a combination curve within 2 or 3% of the ideal could be obtained.

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* The methods of mechanical analysis and the volumetric tests used were those discussed in Taylor and Thompson's "Treatise on Concrete: Plain and Reinforced."

All the experiments seemed to show that the maximum density curve would be a smooth one of approximately the ideal shape, as the different materials gave results differing only in the location of the curve. Finer sand was obtainable from the same bank, but its quality was not as good as the coarser, therefore it was decided to re-screen the stone over a ½-in. screen. This new stone, when combined with the coarser sand, gave a mixture curve very close to that of the ideal (Curve *B,* Fig. 5).

A 50-lb. sample of this combination, and a mixture having a curve which was exactly like the ideal at every screen, were mixed and their volumes measured by taking the distance from the top of a cylindrical can to the surface of the concrete after the sample had been thoroughly tamped in. These two combinations showed the same density, within the limits of error of the experiment, but were distinctly and unworkably lacking in mortar. Proportions varying from this slightly, in both directions, were tried, in order to obtain one having a maximum density. This was finally found to be a mixture of equal parts of sand and stone, the curves for which averaged 6 or 7% higher than the ideal (Curve *D,* Fig. 5). The reason for the variation of the maximum density curve from the ideal may have been because some of the larger aggregate was gravel (the coarser particles of sand), this being approximately one-third, if ⅛ in. is considered as the limit between sand and stone. Another possible reason was the shape of the stone, as the granite crushed into flat and finger-shaped pieces, rather than into the regular tetrahedrons of trap.

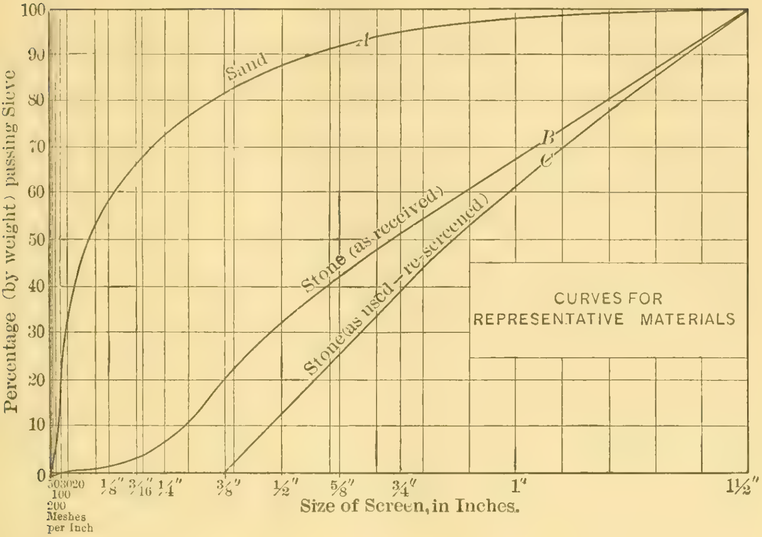
CURVES FOR
REPRESENTATIVE MATERIALS
Sand
A
Stone (as received)
B
Stone (as used—re-screened)
C
Percentage (by weight) passing Sieve
100
90
80
70
60
50
40
30
20
10
0
50 30 20
100
200
Meshes per Inch
1/8″
3/16″
1/4″
3/8″
1/2″
5/8″
3/4″
1″
1½″
Size of Screen, in Inches.

FIG. 4.

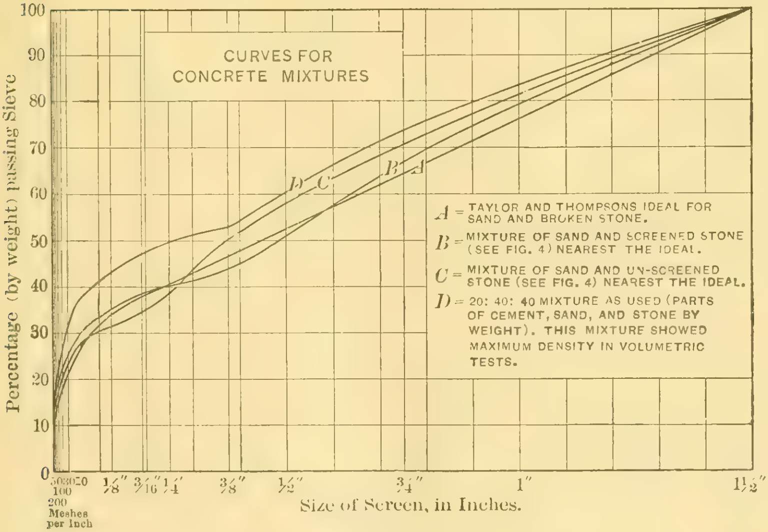
CURVES FOR
CONCRETE MIXTURES
D
C
B
A
A = TAYLOR AND THOMPSONS IDEAL FOR SAND AND BROKEN STONE.
B = MIXTURE OF SAND AND SCREENED STONE (SEE FIG. 4) NEAREST THE IDEAL.
C = MIXTURE OF SAND AND UN-SCREENED STONE (SEE FIG. 4) NEAREST THE IDEAL.
D = 20: 40: 40 MIXTURE AS USED (PARTS OF CEMENT, SAND, AND STONE BY WEIGHT). THIS MIXTURE SHOWED MAXIMUM DENSITY IN VOLUMETRIC TESTS.
Percentage (by weight) passing Sieve
100
90
80
70
60
50
40
30
20
10
0
50 30 20
100
200
Meshes per Inch
1/8″
3/16″
1/4″
3/8″
1/2″
3/4″
1″
1½″
Size of Screen, in Inches.

FIG. 5.

The proportion of cement was determined arbitrarily from the fact that it was thought best by the engineer not to get more than 12 cu. ft. of concrete from a barrel of cement, in order to obtain the required strength and density for a 14-in. wall under a 70-ft. head. A 20:40:40 mixture by weight, of cement, sand, and stone (sand being considered as it was delivered on the job, and containing some gravel, which should properly be classed with the larger aggregate) seemed to satisfy all the conditions. This made about 11½ cu. ft. of concrete per barrel of cement, and showed a maximum density in volumetric tests (Curve *D,* Fig. 5). Samples of the materials were analyzed every day or two, and their curves plotted. From these curves the necessity for any change in the proportions could be noticed. This mixture approximated a 1:1½:3 more nearly than any other standard mixture, and was used with little variation from the bottom of the floor to the overflow line. Above this, approximately, a 1:2:4 mixture was used. In the foundations stone was used up to 2 in. in size, in a mixture which was approximately 1:3:6.

The mechanical analyses of sand and stone were made on samples weighing 6¼ lb. (100 oz.), the scales weighing to ounces and quarters. Samples of sand of this size were handled conveniently, and were very satisfactory. With the stone, however, there was great difficulty in obtaining a truly representative sample so small, even by quartering, hence some of the stone tests showed rather erratic results.

The screens used were: 1½, 1, ¾, ½, ⅜, ¼, $\frac{3}{16}$, and ⅛ in., and 8, 20, 30, 50, 100, and 200 meshes per linear inch. The volumetric tests were made with a 50-lb. sample mixed with a shovel on a 3 by 5-ft. galvanized-iron pan having the edges turned up 1½ in. The sand and cement were mixed dry, then water was added, and then the stone was thoroughly incorporated, following one of the customary methods of hand mixing. In the earlier experiments, the samples were measured in a galvanized-iron can, 10 in. in diameter and 15 in. deep. Later, a piece of 6-in. wrought-iron pipe with a removable flat plate on the bottom was used. The latter gave greater accuracy, as the ratio of depth to cross-section for an equal quantity was greater. The relative volume was determined by measuring the distance from the surface of the sample to the top, as both the cans were truly cylindrical. The samples were put into the receptacle with a bricklayer's trowel, and, as placed, were thoroughly tamped with a 2 by 4-in.

rammer until water rose to the surface. Tests of the voids in the sands and stone showed that the volume of cement was 10% in excess of the voids in the sand, and the volume of mortar was more than 10% in excess of the voids in the stone, as was required by the specifications.

The only water-proofing agent used was Limoid (a patented form of hydrated lime) to the extent of 5% by weight of the cement. Some tests made by the writer seemed to indicate that the addition of lime to cement increased its volume by approximately the volume of the lime added. As the cement was more than enough to fill the voids in the sand, and the mortar to fill the voids in the stone, it is difficult to see wherein lay the advantage of the lime.

The joints were given special care, and the separate day's work seemed to be completely bonded. The top surface of the concrete was thoroughly cleaned each night after it had taken its initial set, and all the laitance was removed, leaving clean sand and stone surfaces exposed. At the beginning of each pouring the surface was covered with grout, and a 1-in. layer of 1:3 mortar was put in before the concrete. The first joint above the floor could not be cleaned before final set, because the floor finish was fresh, and water could not be run over it, so it was found necessary to clean the joint with muriatic acid, and even this was not sufficient for some parts, and they had to be picked.

The floor had a 1-in. granolithic finish, and this was carried up as a plaster coat to the top of the inside bevel. The outside surface was rubbed with carborundum and then painted with a grout wash, except on the base, which, from the ground up to a level 2 in. below the top of the moulding, was picked.

Several porous spots showed dampness on the outside when the tank was first filled. These spots were quite wet in the morning, but the sun dried the most of them in the course of the day. They were treated by forcing grout into them. A cavity was picked in the wall for 7 or 8 in. at the point which seemed to be the source of the leakage, and a ¾-in. nipple, 6 in. long, was bedded in this with 1:2 mortar, the inner end being kept clear by filling stone around it. Grout was then forced in, under a pressure of about 100 lb. per sq. in., furnished by a tank of carbon dioxide gas, such as is used at soda fountains. This eliminated these leaks. Another leak, which appeared along the top of the moulding on the outside, showed as a horizontal crack running nearly half way around the circumference, and varying in amount of leakage. As this was too big to repair by grouting, it was decided to water-proof it from the inside. A paraffin treatment was tried on the wall for 8 ft. above the floor. The wall was heated with charcoal furnaces, and hot paraffin was applied; then the wall was reheated, thus forcing the paraffin into the pores. Several coats of this were applied, but they have not proved sufficiently elastic to keep the wall tight under stress.

Apparently this leak is a stress strain, due to the unequal expansion of the 14-in. wall and the thickened base. The original design had been changed by bringing the top of the inside bevel above the outside moulding to prevent this very difficulty, but without entire success. This is the only structural defect which has been brought to light, thus far, and, in the design of concrete tanks under high pressure, is one of the greatest difficulties to overcome. In addition to the differential expansion, there is also the change of stress from the compression on the bottom to the tension on the wall. If there is no projecting base, the source of the difficulty is simply lowered to the junction of the floor and wall. All the porous spots were on the south side, and most of them were also in the part of the wall nearest to the construction tower, where drippings from the chute fell into the wall forms.

The force engaged was composed of about 25 men: a superintendent, an engineer, 8 carpenters, 14 laborers and an engineman. The carpenters made the wooden and steel forms, and did most of the work on the reinforcing. The laborers did the concrete work, screened the stone, unloaded materials, and acted generally as helpers.

The lower section of the wall and the floor were put in on June 15th in 20 hours of continuous work. Each of the first few sections above the floor took 2 or 3 days. When well started, however, a 3-ft. section was poured in a day. This meant placing the steel and moving up the forms, in which all the men were used, the laborers as helpers, cleaning and greasing the forms, etc., then the stage was raised, usually about noon, and the concrete was poured in the afternoon. It was allowed to set for a few hours while the men were clearing up and getting ready for the next day's work, then in the early evening the concrete foreman and three or four laborers cleaned the top surface. The concrete was finished and ready for the dome 10 weeks after the floor was put in.

The cost of the work is given in Table 1. In considering these costs note should be taken of the fact that certain parts of the work were done under pressure; namely, those parts for which the whole work waited. Other parts were done in a more leisurely manner, owing to the fact that men cannot work continuously at their maximum speed. For example: In the morning the first thing done was to place the steel, secondly, to raise the forms, and thirdly, to raise the stage. All these had to be done before concreting could begin. This work was done by the carpenters working at maxmium speed, some of the laborers acting as helpers. During this time the other laborers were screening stone, washing down the walls, etc., under no great pressure. Later in the afternoon the laborers were working at top speed on the concrete, while the carpenters were placing the necessary bracing on the staging, and getting ready for the next day's work, all at a less forced speed. Consequently, the labor costs for reinforcement, forms, and concrete, show up much better than those for staging, screening stone, finishing the wall, etc.

The materials were delivered by a granite company, on a side track about 100 ft. from the site of the work, for 35 cents a ton, the additional costs being for the labor of unloading and carrying the materials to the site of the work. The steel was carried by hand, and the cement in wheel-barrows. The stone and sand were delivered in piles beside the mixer by carts.

The following prices were paid for labor:

Foreman carpenter.........	48	cents per hour.
" "	43¾ and 45	" " "
Carpenter's helper..........	35	" " "
Engineman	35	" " "
Labor foreman............	50	" " "
Laborers	22½ and 25	" " "

The following prices were paid for materials:

Cement	$1.52	per bbl. (less 30 cents for bags returned).
Sand, delivered at site..	1.15	" yd.
Stone " " " ..	1.07	" "
Limoid	1.00	" bag (100 lb.).
Plaster of Paris.......	2.00	" bbl.
Steel	38.00	" ton, plus the freight.

TABLE 1.—COST OF REINFORCED CONCRETE STAND-PIPE AT WESTERLY, R. I.

Items.	Quantities.	COST PER CUBIC YARD.				Total unit cost.	Total cost.
		Labor.	Plant and stage.	Cement and Limoid.	Aggregate.		
CONCRETE:							
In foundations	337 cu. yd.	$0.90	$1.44	$1.43	$2.09	$5.86	$1 975
" floor	119 " "	1.52	1.44	3.40	1.56	7.92	942
" walls and cornice	423 " "	1.74	2.14	3.34	1.56	8.78	3 714
" parapet	13 " "	1.00	2.14	2.53	1.56	7.23	94
" walk around roof	....	....	....	....	....	....	60
FINISH:							
		COST PER 100 SQ. FT.					
		Labor.	Lumber.	Cement and Limoid.	Aggregate.		
Rubbing and wash on walls	20 866 sq. ft.	$1.14	....	$0.03	....	1.17	244
Picking on plinth	573 " "	14.14	....	....	....	14.14	81
Plaster on plinth	132 lin. ft.	0.46	$0.76	0.04	....	1.26	166
Picking angle for plaster	....	....	....	....	....	....	33
Granolithic on floor and plastering angle	1 767 sq. ft.	5.85	....	4.43	$0.15	10.43	184
Granolithic on cornice	400 " "	2.25	....	1.00	0.15	3.40	14
Granolithic on outside walk	343 " "	1.84	....	3.60	0.15	5.59	19
FORMS:							
		COST PER 100 SQ. FT.					
		Labor.	Plant and stage.	Material.			
Foundation	450 sq. ft.	$18.29	....	$3.40	....	21.69	98
Plinth	1 249 " "	12.50	....	2.20	....	14.70	184
Walls	16 733 " "	4.40	$3.36	5.46	....	13.22	2 212
Walls, triglyphs	1 208 " "	18.00	3.36	20.24	....	41.60	502
Floor	247 " "	5.08	....	2.20	....	7.28	18
Cornice	1 163 " "	38.32	3.36	13.58	....	55.26	643
Parapet	1 225 " "	13.63	....	8.41	....	22.04	269
					Carried forward		$11 452

TABLE 1.—(*Continued.*)

		Cost per Ton.					
		Labor.	Stage.	Material.			
Brought forward.....						....	$11 452
STEEL REINFORCEMENT:							
Rods........................	68 tons	$9.73	$4.50	$39.00	....	53.23	3 619
Crosby clips..................						....	171
Pipe standards for steel......	852 lin. ft. at 20 cents					....	169
Hook spacers................	2 200 " " 1¼ "					....	28
OFFICE AND GENERAL:							
Telephone, stationery, traveling, etc..........						....	200
Board..........						....	320
Travel, and superintendence (at beginning of work)..........						....	56
Watchman, and lights..........						....	50
Delay (waiting for lost cars of steel)..........						....	104
Clearing site, and grading..........						....	120
Setting pipes, manhole cover, and tablet..........						....	17
Miscellaneous extra work, and pipe-laying..........						....	196
Material for steel ladder, $90.50; setting and painting ladder, $44.25..........						....	135
Guastavino tile dome..........						....	1 200
Trap door in dome..........						....	9
Water-proofing (test blocks)..........						....	10
Bond (surety)..........						....	105
						Total..........	$17 961

In Table 1, the cost of the stage is divided between concrete, forms, and steel, in the proportions of ¼, ½, and ¼. In the labor costs for the wall steel, about one-third is charged to bending and two-thirds to placing. In the secondary reinforcement, the cost of bending was a negligible quantity.

The capacity of the stand-pipe is 660 000 gal., and its cost was about 2¾ cents per gal. It was designed and built by the Aberthaw Construction Company, of Boston, Samuel M. Gray, M. Am. Soc. C. E., being Consulting Engineer for the Water-works.

MEMOIRS OF DECEASED MEMBERS

NOTE.—Memoirs will be reproduced in the volumes of *Transactions*. Any information which will amplify the records as here printed, or correct any errors, should be forwarded to the Secretary prior to the final publication.

IRVING HAWKINS, Assoc. M. Am. Soc. C. E.*

Died March 14th, 1911.

Irving Hawkins was born on a farm in South Haven, Long Island, on December 14th, 1863. When he was fourteen years of age his father died, and he was obliged to leave school and assist on the farm. Later, he took up the trade of a brick mason. From his early youth Mr. Hawkins was a student, and though employed during the day, he spent his evenings with his books. He deeply regretted having to give up school, for it was his desire to become an engineer. A substantial dam on the old farm, built by his older brother, Mr. E. C. Hawkins, now Chief Engineer and General Manager of the Morgan-Guggenheim Copper River and Northwestern Railway, in Alaska, and himself, when he was fourteen years old, still stands to attest their bent for engineering.

It was not until 1891, however, that Mr. Hawkins really took up engineering as his life work, but from that time he constantly followed his profession with success. His first employment was as Chainman on irrigation work in Wyoming, but he soon forged ahead as Rodman, Computer, and Levelman on surveys and construction on other large irrigation works in Idaho and Colorado.

In January, 1895, he returned East and remained a year with Mr. Emmett F. Smith, a Civil Engineer, of Patchogue, L. I., who says of him: "A man of sterling worth and integrity—nothing for show or for self—pure gold."

From January, 1896, to the fall of 1898, Mr. Hawkins was employed with the New York State Corps of Engineers on canal and highway work. For the remainder of 1898 he was with the United States Deep Waterway Service, on the Champlain Division.

After spending several months in the office of J. V. Davies, M. Am. Soc. C. E., Mr. Hawkins, in the spring of 1899, took up railroad construction work in West Virginia, remaining in that section from June, 1899, to June, 1902. During this period he was entrusted with highly responsible work, and acquitted himself creditably.

In 1902 he entered the writer's service and remained with him until 1909, during which period he was constantly in responsible charge. Among other work entrusted to him, he is entitled to the credit for the remarkably close results in line and grade in building a 3 500-ft. tunnel, 48 in. finished diameter, and driven through water-bearing drift under air pressure. The small size of the locks, shaft, and tunnel made precise work difficult, yet the headings met within ½ in.

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* Memoir prepared by Alexander Potter, Assoc. M. Am. Soc. C. E.

In whatever branch of engineering Mr. Hawkins was engaged, the same thoroughness characterized his work. He was at his best, however, on outside work.

In December, 1908, he went to Santo Domingo, in charge of a topographic survey for that country. He remained there until December, 1909, by which time revolution, disease, and flood had decimated his party, and had made living in that country so unendurable that he returned to New York.

Shortly after his return, Mr. Hawkins was married to Miss Jennie C. Overton, of Bayport, L. I.

The exposure in Santo Domingo, which had robbed him of his co-workers, tardily claimed him as a victim, for in the spring of 1910, after working for a very short time with the Astoria Light, Heat and Power Company, on Long Island, he suffered from a nervous breakdown, from which he never fully recovered. He had improved so much, however, by March, 1911, that his physicians were of the opinion that he could shortly take up his work again. On March 14th, however, while out for a walk along the railroad several miles above Kingston, N. Y., where he was stopping at the time, he stepped off the track to allow a freight train to pass and was caught by a flying express coming from the opposite direction, and almost instantly killed.

Careful, industrious, attentive to business, thoroughly trustworthy, and rigidly and ruggedly honest, Mr. Hawkins always commanded and retained the respect and confidence of those for whom he worked and of those who worked for him. His cardinal characteristics were unselfishness and rigid devotion to duty.

All through his work Mr. Hawkins felt and expressed deep gratification that it afforded opportunities to make living conditions easier, healthier, and better. Everything that tended toward the uplifting of humanity appealed to him, and because of that came his great love for his work. As an evidence of his humane interest, he was a member of the Red Cross Society, and also a member of the National Child Labor Committee.

He is survived by his widow, two brothers, E. C. Hawkins and Emmett S. Hawkins, and a sister, Mrs. D. F. Glover.

Mr. Hawkins was elected an Associate Member of the American Society of Civil Engineers on May 6th, 1908.

TAKEJIRO SHIMA, Assoc. M. Am. Soc. C. E.*

Died December 22d, 1910.

Takejiro Shima was born on November 23d, 1871, in Saga, in the north of Kyushu Island, Japan. From boyhood he was distinguished for his scholarly ability, and, in 1894, at the age of twenty-three, he was graduated from the Engineering College of the Tokyo Imperial University. In December of the same year, he enlisted as a volunteer in the Japanese Army. During the Japan-China War, in 1894-1895, he exhibited bravery and heroism, and, in March, 1897, was promoted to the rank of Sub-Lieutenant (in engineering).

On his return to civil life, Mr. Shima was engaged by the Nankai Railway Company, and for three years discharged his duties as Engineer with remarkable ability and thoroughness. In June, 1898, he was appointed Railway Engineer of the Imperial Government Railways of Japan.

In April, 1902, Mr. Shima commenced a three-year tour of inspection and study throughout Europe and America, and returned to Japan in April, 1905, with a vast store of present-day railway knowledge.

In October, 1906, he was engaged by the South Manchuria Railway Company, his principal work being the conversion of the Antung-Mukden Light Railway into a broad-gauge line. This was doubtless the company's most important and most difficult enterprise, and the fact that it is now rapidly nearing completion is due in no small measure to Mr. Shima's arduous efforts. From the day of the company's foundation, he was a most prominent figure, and played an important rôle in the construction work of the railway and the reconstruction of the lines from narrow to broad gauge. In November, 1910, the reconstruction work of the Antung-Chikwanshan line was completed, and, on December 11th, Mr. Shima left Dairen for Chikwanshan to inspect the newly constructed section of the broad-gauge line. One afternoon, a week later, while riding in a hand-car, to inspect the finished work between Shahochen and Antung, he met with an accident, which, notwithstanding the skill of the surgeons, caused his death, on December 22d, 1910.

Mr. Shima's meritorious service as Acting Superintendent of the Gas Department of the South Manchuria Railway Company also deserves special mention. Shortly before his death, he was awarded the Sixth Order of Merit of the Sacred Treasure by the Imperial Japanese Government, in recognition of services rendered to the State. He was a good linguist, speaking English, German, and Chinese as well as his native tongue. He was exceedingly modest, and was never known to boast of his profound scholarship. He had a great liking for outdoor sports and exercises, and was noted for his strength.

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* Memoir prepared by M. Numata, Secretary, South Manchuria Railway Company.

Though he passed away at the premature age of forty, with bright prospects, which unfortunately were never to be fulfilled, his merits, his amiability of disposition, and the deeds which he had achieved, will always be remembered by those who had the pleasure of knowing him.

Mr. Shima was elected an Associate Member of the American Society of Civil Engineers on March 4th, 1903.

William P. Morse

20.6

PROCEEDINGS

OF THE

AMERICAN SOCIETY

OF

CIVIL ENGINEERS

VOL. XXXVII—No. 8

P ED
N CIVIL
ENGINE G SOCIETY
BY
WILLIAM P. MORSE

October, 1911

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PROCEEDINGS

OF THE

AMERICAN SOCIETY

OF

CIVIL ENGINEERS

(INSTITUTED 1852)

VOL. XXXVII—No. 8
OCTOBER, 1911

Edited by the Secretary, under the direction of the Committee on Publications.

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NEW YORK 1911

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American Society of Civil Engineers

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ON BITUMINOUS MATERIALS FOR ROAD CONSTRUCTION: W. W. Crosby, A. W. Dean, H. K. Bishop, A. H. Blanchard.

◆

The House of the Society is open from 9 A. M. to 10 P. M. every day, except Sundays, Fourth of July, Thanksgiving Day, and Christmas Day.

HOUSE OF THE SOCIETY—220 WEST FIFTY-SEVENTH STREET, NEW YORK.

TELEPHONE NUMBER................5913 Columbus.
CABLE ADDRESS.................."Ceas, New York."

Vol. XXXVII. OCTOBER, 1911. No. 8.

AMERICAN SOCIETY OF CIVIL ENGINEERS

INSTITUTED 1852

PROCEEDINGS

This Society is not responsible for any statement made or opinion expressed in its publications.

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MINUTES OF MEETINGS

OF THE SOCIETY

September 20th, 1911.—The meeting was called to order at 8.30 P. M.; George H. Pegram, M. Am. Soc. C. E., in the chair; Chas. Warren Hunt, Secretary; and present, also, 87 members and 19 guests.

A paper by William J. Millard, Jun. Am. Soc. C. E., entitled "Mule-Back Reconnaissances," was presented by the Secretary, who also read communications on the subject from Messrs. George D. Snyder and Ernest McCullough. The paper was discussed orally by F. Lavis, M. Am. Soc. C. E.

The Secretary also presented a paper by Lyman E. Bishop, Jun. Am. Soc. C. E., entitled "Economic Canal Location in Uniform Countries," and read communications on the subject from Messrs. H. J. Doolittle, C. E. Shipman, and the author.

The Secretary announced the death of:

Charles Morton Emmons, elected Member, April 1st, 1903; died September 14th, 1911.

Adjourned.

October 4th, 1911.—The meeting was called to order at 8.30 P. M.; President Endicott in the chair; Chas. Warren Hunt, Secretary; and present, also, 146 members and 18 guests.

The minutes of the meetings of the Annual Convention and of September 6th, 1911, were approved as printed in *Proceedings* for September, 1911.

A paper by Wilson Sherman Kinnear, M. Am. Soc. C. E., entitled "The Detroit River Tunnel," was presented by the Secretary, who also read communications on the subject from Messrs. H. A. Carson, H. F. Dunham, and Charles B. Buerger.

The Secretary announced the election of the following candidates on October 3d, 1911:

As Members.

William Brown, Glasgow, Scotland.
William Arnold Christian, Chicago, Ill.
Albert Forster Damon, Jr., Darby, Pa.
Charles Evariste d'Ornellas, Buenos Aires, Argentine Republic.
Amos Alfred Fries, Washington, D. C.
Burr Powell Harrison, Baltimore, Md.
William Julius Krome, Marathon, Fla.
Ralph Steck McCormick, Sault Ste. Marie, Ont., Canada.
James Herbert Hawksworth Muirhead, Havana, Cuba.
Alexander Joseph Norris, Lima, Peru.
James Clarence Ogden, New York City.

As Associate Members.

Augustine Haines Ayers, Suffield, Alta., Canada.
Charles Drewry Batson, St. Paul, Minn.
Joseph Edgar Bell, Hazen, Nev.
Herbert Ernest Bellamy, Brisbane, Queensland, Australia.
Lemuel Berry Joseph Bryan, Chattanooga, Tenn.
Clarence Elmore Carter, Jerome, Idaho.
George Cromwell, Verdi, Nev.
Edson Joseph Davis, Brown, Cal.
Joseph Herbert Digby, Manãos, Brazil.
William Watkyn Edwards, Hydraulic, B. C., Canada.
Kenneth Bales Emerson, New York City.
Donald Patton Falconer, Rochester, N. Y.
Earl Nesby Floyd, Guild, Tenn.
William Lawrence Fulton, Burlington, Vt.
James Pelton Gallager, Muskogee, Okla.
Warren Gardner, Brown Station, N. Y.
James Spencer Hall, Bridgeport, Conn.
James Wilson Hortenstine, Guantanamo, Cuba.

Joel DeWitt Justin, West Shokan, N. Y.
Charles Elliot Lane, Baltimore, Md.
Philip George Lang, Jr., Baltimore, Md.
John Orr MacFeeters, Brooklyn, N. Y.
Frank Henry Mason, Waterville, Me.
Charles Chester Morris, Corregidor, Philippine Islands.
Thomas Edward Morrison, St. Louis, Mo.
Oscar Benjamin Nelson, Minneapolis, Minn.
Leon Hagop Nishkian, Los Angeles, Cal.
Harold Van Dyke Owens, Utica, N. Y.
Thomas Elmer Phipps, Snoqualmie, Wash.
George Moses Purver, Brooklyn, N. Y.
Horace Patton Ramey, Chicago, Ill.
Orrin Randolph, San Acacio, Colo.
Howard Sawyer Reed, Phœnix, Ariz.
Waldemar Spaulding Richmond, Detroit, Mich.
William Henry Rose, Washington, D. C.
Ralph Ernest Sexton, Culebra, Canal Zone, Panama.
Fred Ordway Shutts, San Francisco, Cal.
Wyllys Hard Taylor, Manila, Philippine Islands.
George Louis Thon, Chicago, Ill.
Reenen Jacob van Reenen, Cradock, Cape Province, South Africa.
Clifton White Wilder, Brooklyn, N. Y.

As Associates.

Albert Lereaux Marsh, New York City.
George Cheever Scherer, Montgomery, Ala.

As Juniors.

Ernest Samuel Alderman, Berkeley, Cal.
George Erle Beggs, New York City.
Joseph Jenks Chamberlain, Jr., Ithaca, N. Y.
Jacob Xenab Cohen, New York City.
Herbert Judson Flagg, McMinnville, Ore.
Roy Cecil Gray, Keytesville, Mo.
Laurance Hastings Hart, Buffalo, N. Y.
Frank Miles Kuchar, Schuylerville, N. Y.
John Stalker Longwell, Boise, Idaho.
Frederic William Lyon, Pittsburg, Pa.
Samuel Alexander McWilliams, Powell, Wyo.
Harry Monett, Berkeley, Cal.
Maurice Giesy Parsons, Bishop Creek, Cal.
Carl De Forrest Pollock, Seattle, Wash.

Ralph Ewart Robson, Berkeley, Cal.
Charles Burr Spencer, New York City.
George Ernest Strehan, New York City.
Arthur Hubesty Turner, Atlanta, Ga.

The Secretary announced the transfer of the following candidates on October 3d, 1911:

From Associate Member to Member.

William Thomas Barnes, Newton Center, Mass.
James Henry Haylow, Memphis, Tenn.
Richard Schermerhorn, Jr., New York City.

From Junior to Associate Member.

John Seager Adey, Chicago, Ill.
James Edward Cahill, Chicago, Ill.
Fernando Carbajal, Lima, Peru.
Charles Moss Davis, Fort Worth, Tex.
Elijah Herbert Dunmire, Lawrence, Kans.
Lincoln Ellsworth, New York City.
Harry Crocker Hutchins, New York City.
Albert Jefferson Mayell, New York City.
Paul Leon Pierce, Raleigh, N. C.
John Bernard Sweeney, McKeesport, Pa.
William Earl Weller, Schenectady, N. Y.

The Secretary announced the following deaths:

John Bond Atkinson, elected Member September 5th, 1877; died September 21st, 1911.

Charles Arthur Matcham, elected Member June 5th, 1901; died September 22d, 1911.

James Smith, elected Associate Member November 1st, 1905; Member March 31st, 1908; died February 20th, 1911.

Thomas William Rostad Teigen, elected Junior September 5th, 1905; Associate Member December 1st, 1908; died September 20th, 1911.

Willis Tubbs Turner, elected Associate Member December 7th, 1904; died September 7th, 1911.

Samuel Dale Watkins, elected Junior March 31st, 1908; died September 7th, 1911.

Adjourned.

OF THE BOARD OF DIRECTION

(Abstract)

October 3d, 1911.—President Endicott in the chair; Chas. Warren Hunt, Secretary; and present, also, Messrs. Kimball, Knap, Loomis, Ridgway, Stott, Strobel, and Thompson.

A Special Committee to Formulate Principles and Methods for the Valuation of Railroad Property and Other Public Utilities, was appointed as follows: H. M. Byllesby, Thomas H. Johnson, Leonard Metcalf, Alfred Noble, William G. Raymond, Jonathan P. Snow, Frederic P. Stearns.

The resignation of Edward Herbert Stone as a Member was accepted.

Ballots for membership were canvassed, resulting in the election of 11 Members, 41 Associate Members, 2 Associates, and 18 Juniors, and the transfer of 11 Juniors to the grade of Associate Member.

Three Associate Members were transferred to the grade of Member.

Applications were considered, and other routine business transacted.

Adjourned.

ANNOUNCEMENTS

The House of the Society is open from 9 A. M. to 10 P. M., every day, except Sundays, Fourth of July, Thanksgiving Day, and Christmas Day.

FUTURE MEETINGS

November 1st, 1911.—8.30 P. M.—A regular business meeting will be held and two papers will be presented for discussion, as follows: "Some of the Properties of Oil-Mixed Portland Cement Mortar," by Logan Waller Page, M. Am. Soc. C. E., and "Reinforced Concrete Bridge Across the Almendares River, Havana, Cuba," by Eugene Klapp and W. J. Douglas, Members, Am. Soc. C. E.

These papers were printed in *Proceedings* for September, 1911.

November 15th, 1911.—8.30 P. M.—Two papers will be presented for discussion at this meeting, as follows: "A Reinforced Concrete Stand-Pipe," by W. W. Clifford, Jun. Am. Soc. C. E., and "Retrogression in the Tensile Strength of Cement," by J. M. O'Hara, Assoc. M. Am. Soc. C. E.

Mr. Clifford's paper was printed in *Proceedings* for September, 1911, and Mr. O'Hara's paper appears in this number of *Proceedings*.

December 6th, 1911.—8.30 P. M.—This will be a regular business meeting. Two papers will be presented for discussion: "Experiments on the Flow of Water in Wood Stave Pipes," by E. A. Moritz, Assoc. M. Am. Soc. C. E., and "The St. Croix River Bridge," by C. A. P. Turner, M. Am. Soc. C. E.

These papers are printed in this number of *Proceedings*.

December 20th, 1911.—8.30 P. M.—At this meeting two papers will be presented for discussion, as follows: "Construction of the Morena Rock Fill Dam, San Diego County, California," by M. M. O'Shaughnessy, M. Am. Soc. C. E., and "The Halligan Dam: A Reinforced Masonry Structure," by G. N. Houston, M. Am. Soc. C. E.

These papers are printed in this number of *Proceedings*.

SPECIAL MEETINGS FOR TOPICAL DISCUSSION

Meetings for the discussion of "Road Construction and Maintenance" will be held on Friday and Saturday, January 19th and 20th, 1912 (the days following the close of the Annual Meeting of the Society).

As soon as arrangements are completed, the hours for holding these meetings, topics for discussion, names of speakers, etc., will be published.

LIST OF NOMINEES FOR THE OFFICES TO BE FILLED AT THE ANNUAL ELECTION, JANUARY 17th, 1912.

The following list of nominees for the offices to be filled at the Annual Meeting, January 17th, 1912, received from the Nominating Committee, was presented to the Board of Direction at its meeting on September 5th, 1911. The list has already been mailed to all Corporate Members:

For President, to serve one year:

John A. Ockerson, St. Louis, Mo.

For Vice-Presidents, to serve two years:

Charles S. Churchill, Roanoke, Va.
Charles D. Marx, Stanford University, Cal.

For Treasurer, to serve one year:

Joseph M. Knap, New York City.

For Directors, to serve three years:

Lincoln Bush, New York City	District No. 1
T. Kennard Thomson, New York City	District No. 1
Emil Gerber, Pittsburg, Pa	District No. 4
William Cain, Chapel Hill, N. C	District No. 6
E. C. Lewis, Nashville, Tenn	District No. 6
W. A. Cattell, San Francisco, Cal	District No. 7

SEARCHES IN THE LIBRARY

In January, 1902, the Secretary was authorized to make searches in the Library, upon request, and to charge therefor the actual cost to the Society for the extra work required. Since that time many searches have been made, and bibliographies and other information on special subjects furnished.

The resulting satisfaction, to the members, who have made use of the resources of the Society in this manner, has been expressed frequently, and leaves little doubt that, if it were generally known to the membership that such work would be undertaken, many would avail themselves of it.

The cost is trifling compared with the value of the time of an engineer who looks up such matters himself, and the work can be performed quite as well, and much more quickly, by persons familiar with the Library.

In asking that such work be undertaken, members should specify clearly the subject to be covered, and whether references to general books only are desired, or whether a complete bibliography, involving search through periodical literature, is desired.

In reference to this work, the Appendices* to the Annual Reports of the Board of Direction for the years ending December 31st, 1906, and December 31st, 1910, contain summaries of all searches made to date.

PAPERS AND DISCUSSIONS

Members and others who take part in the oral discussions of the papers presented are urged to revise their remarks promptly. Written communications from those who cannot attend the meetings should be sent in at the earliest possible date after the issue of a paper in *Proceedings.*

All papers accepted by the Publication Committee are classified by the Committee with respect to their availability for discussion at meetings.

Papers which, from their general nature, appear to be of a character suitable for oral discussion, will be published as heretofore in *Proceedings,* and set down for presentation to a future meeting of the Society, and, on these, oral discussions, as well as written communications, will be solicited.

All papers which do not come under this heading, that is to say, those which, from their mathematical or technical nature, in the opinion of the Committee, are not adapted to oral discussion, will not be scheduled for presentation to any meeting. Such papers will be published in *Proceedings* in the same manner as those which are to be presented at meetings, but written discussions, only, will be requested for subsequent publication in *Proceedings* and with the paper in the volumes of *Transactions.*

LOCAL ASSOCIATIONS OF MEMBERS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS

San Francisco Association

The San Francisco Association of Members of the American Society of Civil Engineers holds regular bi-monthly meetings, with banquet, and weekly informal luncheons. The former are held at 6 P. M., at the Palace Hotel, on the third Friday of February, April, June, August, October, and December, the last being the Annual Meeting of the Association.

Informal luncheons are held at 12.15 P. M. every Wednesday, and the place of meeting may be ascertained by communicating with the Secretary of the Association, E. T. Thurston, Jr., M. Am. Soc. C. E., 713 Mechanics' Institute, 57 Post Street.

The by-laws of the Association provide for the extension of hospitality to any member of the Society who may be temporarily in San Francisco, and any such member will be gladly welcomed as a guest.

Proceedings, Vol. XXXIII, p. 20 (January, 1907); Vol. XXXVII, p. 28 (January, 1911).

(Abstract of Minutes of Meeting)

August 18th, 1911.—The meeting was called to order; President Derleth in the chair; E. T. Thurston, Jr., Secretary; and present, also, 71 members and guests.

The Secretary announced that the membership of the Association was now 143.

C. H. Snyder, M. Am. Soc. C. E., presented a paper on "Some Recent Developments in Concrete-Steel Building Construction," illustrating his remarks with stereopticon views, and the subject was discussed by Messrs. Boggs, Couchot, Chew, Doerfling, Derleth, Wing, Poss, and Hicks.

Adjourned.

Colorado Association

The meetings of the Colorado Association of Members of the American Society of Civil Engineers are held on the second Saturday of each month, except July and August. The hour and place of meeting are not fixed, but this information will be furnished on application to the Secretary, Gavin N. Houston, M. Am. Soc. C. E., 409 Equitable Building, Denver, Colo. The meetings are usually preceded by an informal dinner. Members of the American Society of Civil Engineers will be welcomed at these meetings.

Weekly luncheons are held on Wednesdays, and until further notice, will take place at The Colorado Traffic Club.

Visiting members are urged to attend the meetings and luncheons.

(Abstract of Minutes of Meeting)

September 9th, 1911.—The meeting was called to order; Vice-President Anderson in the chair; G. N. Houston, Secretary; and present, also, 12 members and 2 guests.

The minutes of the Annual Meeting were read and approved.

A paper on "The Design and Construction of the Alameda Avenue Subway," was presented by V. A. Kauffman, Assoc. M. Am. Soc. C. E.

Adjourned.

PRIVILEGES OF ENGINEERING SOCIETIES EXTENDED TO MEMBERS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS

Members of the American Society of Civil Engineers will be welcomed by the following Engineering Societies, both to the use of their Reading Rooms and at all Meetings:

American Institute of Mining Engineers, 29 West Thirty-ninth Street, New York City.

American Society of Mechanical Engineers, 29 West Thirty-ninth Street, New York City.

Architekten-Verein zu Berlin, Wilhelmstrasse 92, Berlin W, 66, Germany.

Associação dos Engenheiros Civis Portuguezes, Lisbon, Portugal.

Australasian Institute of Mining Engineers, Melbourne, Victoria, Australia.

Boston Society of Civil Engineers, 715 Tremont Temple, Boston, Mass.

Brooklyn Engineers' Club, 117 Remsen Street, Brooklyn, N. Y.

Canadian Society of Civil Engineers, 413 Dorchester Street, West, Montreal, Que., Canada.

Civil Engineers' Society of St. Paul, St. Paul, Minn.

Cleveland Engineering Society, Chamber of Commerce Building, Cleveland, Ohio.

Cleveland Institute of Engineers, Middlesbrough, England.

Dansk Ingeniorforening, Amaliegade 38, Copenhagen, Denmark.

Engineers' and Architects' Club of Louisville, Ky., 303 Norton Building, Fourth and Jefferson Streets, Louisville, Ky.

Engineers' Club of Baltimore, Baltimore, Md.

Engineers' Club of Minneapolis, 17 South Sixth Street, Minneapolis, Minn.

Engineers' Club of Philadelphia, 1317 Spruce Street, Philadelphia, Pa.

Engineers' Club of St. Louis, 3817 Olive Street, St. Louis, Mo.

Engineers' Club of Toronto, 96 King Street, West, Toronto, Ont., Canada.

Engineers' Society of Northeastern Pennsylvania, 302 Board of Trade Building, Scranton, Pa.

Engineers' Society of Pennsylvania, 219 Market Street, Harrisburg, Pa.

Engineers' Society of Western Pennsylvania, 2511 Oliver Building, Pittsburg, Pa.

Institute of Marine Engineers, 58 Romford Road, Stratford, London, E., England.

Institution of Engineers of the River Plate, Buenos Aires, Argentine Republic.

Institute of Naval Architects, 5 Adelphi Terrace, London, W. C., England.

Junior Institution of Engineers, 39 Victoria Street, Westminster, S. W., London, England.

Koninklijk Instituut van Ingenieurs, The Hague, The Netherlands.

Louisiana Engineering Society, 321 Hibernia Bank Building, New Orleans, La.

Memphis Engineering Society, Memphis, Tenn.

Midland Institute of Mining, Civil and Mechanical Engineers, Sheffield, England.

Montana Society of Engineers, Butte, Montana.

North of England Institute of Mining and Mechanical Engineers, Newcastle-upon-Tyne, England.

Oesterreichischer Ingenieur= und Architekten=Verein, Eschenbachgasse 9, Vienna, Austria.

Pacific Northwest Society of Engineers, 803 Central Building, Seattle, Wash.

Rochester Engineering Society, Rochester, N. Y.

Sachsischer Ingenieur- und Architekten-Verein, Dresden, Germany.

Sociedad Colombiana de Ingenieros, Bogota, Colombia.

Sociedad de Ingenieros del Peru, Lima, Peru.

Societe des Ingenieurs Civils de France, 19 Rue Blanche, Paris, France.

Society of Engineers, 17 Victoria Street, Westminster, S. W., London, England.

Svenska Teknologforeningen, Brunkebergstorg 18, Stockholm, Sweden.

Tekniske Forening, Vestre Boulevard 18–1, Copenhagen, Denmark.

Western Society of Engineers, 1737 Monadnock Block, Chicago, Ill.

ACCESSIONS TO THE LIBRARY

(From September 13th to October 10th, 1911)

DONATIONS.*

COST KEEPING AND SCIENTIFIC MANAGEMENT.

By Holden A. Evans. Cloth, 9½ x 6 in., illus., 9 + 252 pp. New York and London, McGraw-Hill Book Company, 1911. $3.00.

While this book is written for jobbing shops and small manufacturing plants, the author states that he hopes it will be found of interest by the officials of large manufacturing establishments and shipbuilding plants. The first chapters are devoted to methods of cost keeping, which are stated to be simple, to require but little clerical work, and easily adapted to meet the requirements of any work. The methods of management described in the second part of the book are intended, it is stated, to aid the manager in his first steps toward scientific management. The Contents are: The Importance of Accurate Costs; The Purposes of a Cost System; The Various Elements of Cost; Distribution of Indirect Costs; Production Order, Shop Order and Cost Section Records; Indirect Charges; Supervision of the Expense Accounts; Methods Followed in the Payment of Labor; Management; Wasted Time Detected by Time Studies; The Principles of Scientific Management Which Can be Followed by a Manager; Methods Which Lead Towards Scientific Management; Machine Shop Methods; Organization of a Smith Shop, a Wood Working Shop, and a Canvas and Flag Shop; Reductions in Cost Due to Scientific Methods; Index.

APPLIED ELECTROCHEMISTRY.

By M. de Kay Thompson. Cloth, 9 x 6 in., illus., 12 + 329 pp. New York, The Macmillan Company, 1911. $2.10.

The author states that this book is a compilation of notes for a course of lectures on Applied Electrochemistry at the Massachusetts Institute of Technology, in which course he aimed to give an account of the most important electrochemical industries and the principal applications of electrochemistry in the laboratory. It is stated that each subject is discussed both from the theoretical and from the technical point of view, a knowledge of theoretical chemistry being assumed in the theoretical part. There is an appendix which contains the more important constants necessary in electrochemical calculations, and author and subject indices. The Chapter Headings are: Coulometers or Voltameters; Electrochemical Analysis; Electroplating, Electrotyping, and the Production of Metallic Objects; Electrolytic Mining and Refining of Metals in Aqueous Solutions; Electrolytic Reduction and Oxidation; Electrolysis of Alkali Chlorides; The Electrolysis of Water; Primary Cells; The Lead Storage Battery; The Edison Storage Battery; The Electric Furnace; Products of the Resistance and Arc Furnace; The Electrometallurgy of Iron and Steel; The Fixation of Atmospheric Nitrogen; The Production of Ozone.

A TREATISE ON HYDRAULICS.

By Hector J. Hughes and Arthur T. Safford, Members, Am. Soc. C. E. Cloth, 9 x 6 in., illus., 14 + 505 pp. New York, The Macmillan Company, 1911. $3.75.

This book, it is stated, is intended as a textbook for technical schools and colleges on certain parts of the subject of hydraulics, namely, water pressure, the stability of simple structures subjected to water pressure, the flow of water, the measurement of flow, and the fundamental principles of hydraulic motors. All discussion of the design of hydraulic motors, and other hydraulic machinery, as well as of the design of water power plants, has purposely been omitted as too important to be treated in a work of this size. It has been the authors' aim, it is stated, to present as simply and as directly as possible the recognized methods of solving hydraulic problems; to point out difficulties which may arise in practice and how to meet them; to present empirical coefficients and formulas, pointing out their limitations, and giving experimental values and the limits of experiments; to provide tables of suitable precision and extent, and also diagrams; and to indicate the present state of the practice. In the subject-matter related formulas, coefficients, and the practice of water measurements are said to be connected as closely as possible, and each subdivision is finished as it is taken up, problems for solution being given at the end of each chapter. For formulas of flow in general, Bennoulli's theorem is used as a basis. In the chapters devoted to the flow of water are included methods of measurement, descriptions of the various instruments used for measurement, formulas for flow, etc., rod float measurements, especially current meter measurements, being, it is stated, discussed in detail. Several kinds of logarithmic diagrams of discharge and well-known tables of coefficients are given, and in Table XLIX an extended study of pipe experiments will be found, which includes experiments on old pipes.

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* Unless otherwise specified, books in this list have been donated by the publishers.

AMERICAN SCHOOL BUILDING STANDARDS.

By Wilbur T. Mills. Leather, 7 x 4 in., illus., 324 pp. Columbus, Ohio, Franklin Educational Publishing Company, 1911. (Donated by the Author.)

The author's controlling motive has been, it is stated, to condense and standardize the best present-day practice in the design and construction of public school buildings in the United States, so as to produce, in this book, a compact handbook for ready reference on this subject. In an Appendix, the author gives details of school fittings and equipment, as well as illustrations of sanitary fixtures, correct heating and ventilating apparatus, shower baths, etc. It also contains floor plans and illustrations of the best types of present-day American school buildings. The Chapter Headings are: The Man Who Knows; Selecting an Architect; The School Room; The School Building; Special Rooms; Sanitation; Fireproofing and Panic Proofing; Heating of School Buildings; Ventilation—General Principles; Systems of Ventilation; School Laws of States; Code of Boston School House Commission; Competition Program; Canons of Ethics, American Institute of Architects; Schedule of Fees, American Institute of Architects.

McGRAW ELECTRIC RAILWAY MANUAL, 1911.

The Red Book of American Street Railway Investments. Edited by Frederic Nicholas. Eighteenth Annual Number. Cloth, 13 x 10 in., illus., 36 + 430 pp. New York, McGraw Publishing Company, 1911. $5.00.

Prior to 1911, this book was published under the title "American Street Railway Statistics." In a secondary title to this edition, it is stated that the work is a manual of the securities, traffic statistics, earnings, officers, and equipment of street and interurban railways in the United States, Canada, Cuba, and the West Indies. The contents include, for the first time, statistics showing the improved principal returns of operating electric railway companies reporting for 1910, which previously have been published in one of the weekly issues of the *Electric Railway Journal.* The subject-matter is arranged alphabetically by State and city and includes a short history of each road, its capital stock, funded debt, statistics of operation, traffic, and plant. This is followed by the names and addresses of the officers of each company, as well as the addresses of the general offices, power stations, and repair shops. Maps of various cities, showing railway lines, are included. At the end of the book, the names and addresses of the officers of the National and State Railroad Commissions are given, together with lists of the officers of the various street and interurban associations.

THE ELEMENTS OF ELECTRICAL TRANSMISSION.

A Text-Book for Colleges and Technical Schools. By Olin Jerome Ferguson. Cloth, 8½ x 6 in., illus., 7 + 457 pp. New York, The Macmillan Company, 1911. $3.50.

The author's aim has been to group his subjects so as to provide an elemental study of the broad subject of the generation, transmission, distribution, and utilization of power by electrical processes. Several of the subjects presented may be found elsewhere, but others, such as self-induction and capacity of polyphase circuits as derived from single-phase circuits, line calculations, standing waves, traveling waves, curve calculations, etc., are stated to be new. Several methods of making line calculations, each more or less commonly used, are given in detail in order that contrasts may be made and the simplicity of the series approximation emphasized. In the chapter on Distribution a summary is made of the chief characteristics of the various units which go to make up the load on an electrical system and which determine its distinctive features. The Chapter Headings are: Conductors and Insulation; Insulating Supports; Poles and Towers; Aerial Line Construction; Underground Line Construction; Switchboards and Protective Devices; Circuits; Constants of Circuits; Generation; Transmission; Distribution; Measurements and Contract Rules; Line Phenomena; Index.

PRACTICAL APPLIED ELECTRICITY.

A Book in Plain English for the Practical Man. Theory, Practical Applications, and Examples. By David Penn Moreton. Leather, 7¼ x 4¾ in., illus., 438 pp. Chicago, The Reilly & Britton Co., 1911. $2.00.

The text is based, it is stated, to a certain extent, on a series of lectures given by the author in the evening classes in the Department of Electrical Engineering at Armour Institute of Technology. The book is intended primarily to provide a thorough understanding of the fundamental principles of the subject for persons who desire a practical knowledge of the subject, but who are unable to take a complete course in electrical engineering. Numerous examples are given and solved, which illustrate the practical application of laws and principles. Although not intended as a textbook, the author states that it is especially adapted for use in High and Manual Training Schools. The Chapter Headings are: Electrical Circuit and Electrical Units; Calculation of Resistance; Series and Divided Circuits, Measurement of Resistance; Primary Batteries; Magnetism; Electromagnetism; Electromagnetic Induction; Fundamental Theory of the Dynamo; Electrical Instruments and Effects of a Current; Direct-Current Generators; Direct-Current Motors; Armatures for Direct-Current Dynamos; Storage Batteries, Their Application and Management; Distribution and Operation; Diseases of Direct-Current Dynamos; Electric Lighting; Electric Wiring; Alternating-Current Circuit; Alternating-Current Machinery; Resuscitation; Logarithms and Reference Tables; Index.

THE DESIGN AND CONSTRUCTION OF DAMS

Including Masonry, Earth, Rock-Fill, Timber, and Steel Structures, Also the Principal Types of Movable Dams. By Edward Wegmann, M. Am. Soc. C. E. Sixth Edition, Revised and Enlarged. Cloth, 12 x 9¾ in., illus., 16 + 529 pp. New York, John Wiley & Sons; London, Chapman & Hall, Limited, 1911. $6.00. (Donated by the Author and Publishers.)

In this, the sixth edition of this work, the subject-matter has been divided into four parts and an Appendix. In Part I, which treats of the design and construction of masonry dams, the descriptions of important dams of various kinds are stated to have been brought up to date. Many practical details, including some cost data of the New Croton Dam, are given in describing the various dams built for the City of New York. Part II treats of fixed dams other than masonry dams, and Part III is devoted to descriptions of movable dams. Two new chapters have been added to this part, one on Overflow Weirs, which includes a discussion of designs of weirs built on sand and gravel foundations in the United States, in India, and in Egypt, and another on Coffer-dams which gives the various types of such structures and descriptions of coffer-dams actually built. In Part IV descriptions of a number of dams recently built, including the Gatun Dam and the raising of the Assuan Dam, are given. The Appendix contains Specifications for the New Croton Dam; twenty-five tables giving dimensions and strength of various profile types, proofs of the principles discussed, and practical examples of the methods proposed for designing profiles, etc.; discussions of recent partial failures of several dams; descriptions of beaver dams, trembling dams, and tinker dams; cost data of the new Croton Dam; and a bibliography of the various types of dams described by the author. This edition is illustrated by 198 figures in the text and 157 plates. There is also an index of nine pages. The Contents are: Part I, Design and Construction of Masonry Dams: Introduction; Distribution of Pressure in a Wall of Masonry; Theoretical Profiles; Various Applications of Equations (1) to (14); Practical Profiles; Construction; Spanish Dams; French Dams; Dams in Various Parts of Europe; Dams in Algiers; Dams in Egypt; Dams in Asia and Australasia; American Dams; Reinforced Concrete Dams. Part II, Earthen, Rock-Fill, Timber, and Steel Dams: Earthen Dams; Dams Made by the Hydraulic Process; Rock-Fill Dams; Timber Dams; Steel Dams. Part III, Movable Dams, Coffer-dams, and Overflow Weirs: Frame Dams; Shutter Dams; Dams with Bear-trap Gates; Stoney Roller Sluice-gates; Rolling Dams; Butterfly Dams, etc.; Coffer-dams; Overflow Weirs. Part IV, Recent Dams; Appendix.

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Cost-Keeping for Manufacturing Plants. By Sterling H. Bunnell. D. Appleton & Co., New York, 1911.

Electric Trains. By H. M. Hobart. D. Van Nostrand Company, New York, 1910.

The Design and Construction of Ships. By John Harvard Biles. Vol. 2, Stability, Resistance, Propulsion, and Oscillations of Ships. J. B. Lippincott Company, Philadelphia; Charles Griffin and Company, Limited, London, 1911.

Illustrierte Technische Wörterbücher. Von Wilhelm Wagner. Band IX, Werkzeugmaschinen: Metallbearbeitung, Holzbearbeitung. R. Oldenbourg, München und Berlin, 1910.

Metallurgy of Tin. By Henry Lewis. McGraw-Hill Book Company, New York and London, 1911.

Lectures on Illuminating Engineering. Delivered at the Johns Hopkins University, October and November, 1910, Under the Joint Auspices of the University and the Illuminating Engineering Society. Vol. 1–2. The Johns Hopkins Press, Baltimore, 1911.

SUMMARY OF ACCESSIONS

(From September 13th to October 10th, 1911)

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Noska, George Albert. Care, D. Everett Waid, 1 Madison Ave., New York City	Jun. Assoc. M. M.	Mar. 31, 1896 Sept. 3, 1902 Sept. 5, 1911
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RESIGNATIONS

MEMBERS	Date of Resignation.
Stone, Edward Herbert............................	Oct. 3, 1911

DEATHS

Atkinson, John Bond. Elected Member September 5th, 1877; died September 2d, 1911.

Emmons, Charles Morton. Elected Member April 1st, 1903; died September 14th, 1911.

Matcham, Charles Arthur. Elected Member June 5th, 1901; died September 22d, 1911.

Smith, James. Elected Associate Member November 1st, 1905; Member March 31st, 1908; died February 20th, 1911.

Teigen, Thomas William Rostad. Elected Junior September 5th, 1905; Associate Member December 1st, 1908.

Turner, Willis Tubbs. Elected Associate Member December 7th, 1904; died September 7th, 1911.

Total Membership of the Society, October 10th, 1911, 6 210.

MONTHLY LIST OF RECENT ENGINEERING ARTICLES OF INTEREST

(September 11th to October 9th, 1911)

NOTE.—*This list is published for the purpose of placing before the members of the Society, the titles of current engineering articles, which can be referred to in any available engineering library, or can be procured by addressing the publication directly, the address and price being given wherever possible.*

LIST OF PUBLICATIONS

In the subjoined list of articles, references are given by the number prefixed to each journal in this list:

(1) *Journal,* Assoc. Eng. Soc., 31 Milk St., Boston, Mass., 30c.
(2) *Proceedings,* Engrs. Club of Phila., 1317 Spruce St., Philadelphia, Pa.
(3) *Journal,* Franklin Inst., Philadelphia, Pa., 50c.
(4) *Journal,* Western Soc. of Engrs., Monadnock Blk., Chicago, Ill.
(5) *Transactions,* Can. Soc. C. E., Montreal, Que., Canada.
(6) *School of Mines Quarterly,* Columbia Univ., New York City, 50c.
(8) *Stevens Institute Indicator,* Stevens Inst., Hoboken, N. J., 50c.
(9) *Engineering Magazine,* New York City, 25c.
(10) *Cassier's Magazine,* New York City, 25c.
(11) *Engineering* (London), W. H. Wiley, New York City, 25c.
(12) *The Engineer* (London), International News Co., New York City, 35c.
(13) *Engineering News,* New York City, 15c.
(14) *The Engineering Record,* New York City, 12c.
(15) *Railway Age Gazette,* New York City, 15c.
(16) *Engineering and Mining Journal,* New York City, 15c.
(17) *Electric Railway Journal,* New York City, 10c.
(18) *Railway and Engineering Review,* Chicago, Ill., 10c.
(19) *Scientific American Supplement,* New York City, 10c.
(20) *Iron Age,* New York City, 10c.
(21) *Railway Engineer,* London, England, 25c.
(22) *Iron and Coal Trades Review,* London, England, 25c.
(23) *Bulletin,* American Iron and Steel Assoc., Philadelphia, Pa.
(24) *American Gas Light Journal,* New York City, 10c.
(25) *American Engineer,* New York City, 20c.
(26) *Electrical Review,* London, England.
(27) *Electrical World,* New York City, 10c.
(28) *Journal,* New England Water-Works Assoc., Boston, Mass., $1.
(29) *Journal,* Royal Society of Arts, London, England, 15c.
(30) *Annales des Travaux Publics de Belgique,* Brussels, Belgium.
(31) *Annales* de l'Assoc. des Ing. Sortis des Ecoles Spéciales de Gand, Brussels, Belgium.
(32) *Mémoires et Compte Rendu des Travaux,* Soc. Ing. Civ. de France, Paris, France.
(33) *Le Génie Civil,* Paris, France.
(34) *Portefeuille Economiques des Machines,* Paris, France.
(35) *Nouvelles Annales de la Construction,* Paris, France.
(37) *Revue de Mécanique,* Paris, France.
(38) *Revue Générale des Chemins de Fer et des Tramways,* Paris, France.
(41) *Modern Machinery,* Chicago, Ill., 10c.
(42) *Proceedings,* Am. Inst. Elec. Engrs., New York City, 50c.
(43) *Annales des Ponts et Chaussées,* Paris, France.
(44) *Journal,* Military Service Institution, Governors Island, New York Harbor, 50c.
(45) *Mines and Minerals,* Scranton, Pa., 20c.
(46) *Scientific American,* New York City, 8c.
(47) *Mechanical Engineer,* Manchester, England.
(48) *Zeitschrift,* Verein Deutscher Ingenieure, Berlin, Germany.
(49) *Zeitschrift für Bauwesen,* Berlin, Germany.
(50) *Stahl und Eisen,* Düsseldorf, Germany.
(51) *Deutsche Bauzeitung,* Berlin, Germany.
(52) *Rigasche Industrie-Zeitung,* Riga, Russia.
(53) *Zeitschrift,* Oesterreichischer Ingenieur und Architekten Verein, Vienna, Austria.
(54) *Transactions,* Am. Soc. C. E., New York City, $4.
(55) *Transactions,* Am. Soc. M. E., New York City, $10.
(56) *Transactions,* Am. Inst. Min. Engrs., New York City, $5.

(57) *Colliery Guardian,* London, England.
(58) *Proceedings,* Engrs.' Soc. W. Pa., 803 Fulton Bldg., Pittsburg, Pa., 50c.
(59) *Transactions,* Mining Inst. of Scotland, London and Newcastle-upon-Tyne, England.
(60) *Municipal Engineering,* Indianapolis, Ind., 25c.
(61) *Proceedings,* Western Railway Club, 225 Dearborn St., Chicago, Ill., 25c.
(62) *Industrial World,* 59 Ninth St., Pittsburg, Pa.
(63) *Minutes of Proceedings,* Inst. C. E., London, England.
(64) *Power,* New York City, 20c.
(65) *Official Proceedings,* New York Railroad Club, Brooklyn, N. Y., 15c.
(66) *Journal of Gas Lighting,* London, England, 15c.
(67) *Cement and Engineering News,* Chicago, Ill., 25c.
(68) *Mining Journal,* London, England.
(70) *Engineering Review,* New York City, 10c.
(71) *Journal,* Iron and Steel Inst., London, England.
(71*a*) *Carnegie Scholarship Memoirs,* Iron and Steel Inst., London, England.
(73) *Electrician,* London, England, 18c.
(74) *Transactions,* Inst. of Min. and Metal., London, England.
(75) *Proceedings,* Inst. of Mech. Engrs., London, England.
(76) *Brick,* Chicago, Ill., 10c.
(77) *Journal,* Inst. Elec. Engrs., London, England.
(78) *Beton und Eisen,* Vienna, Austria.
(79) *Forscherarbeiten,* Vienna, Austria.
(80) *Tonindustrie Zeitung,* Berlin, Germany.
(81) *Zeitschrift für Architektur und Ingenieurwesen,* Wiesbaden, Germany.
(83) *Progressive Age,* New York City, 15c.
(84) *Le Ciment,* Paris, France.
(85) *Proceedings* Am. Ry. Eng. and M. of W. Assoc., Chicago, Ill.
(86) *Engineering-Contracting,* Chicago, Ill., 10c.
(87) *Roadmaster and Foreman,* Chicago, Ill., 10c.
(88) *Bulletin* of the International Ry. Congress Assoc., Brussels, Belgium.
(89) *Proceedings,* Am. Soc. for Testing Materials, Philadelphia, Pa.
(90) *Transactions,* Inst. of Naval Archts., London, England.
(91) *Transactions,* Soc. Naval Archts. and Marine Engrs., New York City.
(92) *Bulletin,* Soc. d'Encouragement pour l'Industrie Nationale, Paris, France.
(93) *Revue de Métallurgie,* Paris, France, 4 fr. 50.
(94) *The Boiler Maker,* New York City, 10c.
(95) *International Marine Engineering,* New York City, 20c.
(96) *Canadian Engineer,* Toronto, Ont., Canada, 15c.
(97) *Turbine,* Berlin, Germany, 1 Mark.
(98) *Journal,* Engrs. Soc. Pa., 219 Market St., Harrisburg, Pa., 30c.
(99) *Proceedings,* Am. Soc. of Municipal Improvements, New York City, $1.50.
(100) *Professional Memoirs,* Corps of Engrs., U. S. A., Washington, D. C., $1.
(101) *Metal Worker,* New York City, 10c.
(102) *Organ für die Fortschritte des Eisenbahnwesens,* Wiesbaden, Germany.
(103) *Mining and Scientific Press,* San Francisco, Cal., 10c.
(104) *The Surveyor and Municipal and County Engineer,* London, England, 6d.
(105) *Metallurgical and Chemical Engineering,* New York City, 25c.
(106) *Transactions,* Inst. of Mining Engrs., London, England, 6 shillings.
(107) *Schweizerische Bauzeitung,* Zurich, Switzerland.
(108) *Southern Machinery,* Atlanta, Ga., 10c.

LIST OF ARTICLES.

Bridges.

The Reconstruction and Widening of Arpley Bridge, Warrington.* William Dawson. (63) Vol. 184.

Reconstruction of the Road-Bridge over the River Tame at Lea Marston.* Victor Michael Barrington-Ward. (63) Vol. 184.

Oakland Avenue Reinforced-Concrete Bridge in Piedmont, California.* W. P. Day, Assoc. M. Am. Soc. C. E. (13) Sept. 14.

The New Intermediate Shore Towers of the Williamsburg Bridge.* (14) Sept. 16.

Concrete Bridge in Philippines.* Jay A. Rossiler. (From *The Contractor.*) (96) Sept. 28.

The Sitter Viaduct. (46) Sept. 30.

The Pratt Street Bridge, Baltimore.* (14) Sept. 30.

Secondary Stresses.* F. C. Kunz, M. Am. Soc. C. E. (13) Oct. 5.

The Columbia River Bridge of the North Coast Railroad Co. (now the Oregon-Washington R. R. & N. Co.)* F. L. Pitman, M. Am. Soc. C. E. (13) Oct. 5.

Rapid Bridge Work on the Boston & Albany.* W. F. Steffens. (15) Oct. 6.

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*Illustrated.

Bridges—(Continued).

Reinforcing Williamsburg Bridge Trusses.* (14) Oct. 7.
How Pedestrians have been Enabled to Cross the Grand Central Terminal Yard during its Reconstruction; The Details of a Movable Footbridge with Suspended Floor.* (14) Oct. 7.
Port de Cette, Pont Tournant de la Gare à Manœuvre Electrique.* Guibal. (43) July.
Notice sur la Construction du Pont de Montanges au lieu dit Moulin des Pierres.* Ed. Picard. (43) July.
Pont en Béton Armé, au Plan du Var; Chemin de Fer Electrique de la Vallée de la Vésuvie (Alpes-Maritimes).* James Boudet. (35) Serial beginning Sept.
Note sur l'Exécution d'une Passerelle en Béton de Ciment Fretté et Armé au-dessus des Voies de la Gare de Périgueux.* Millon d'Ainval. (38) Sept.
Le Pont de Montanges au lieu dit "Moulin des Pierres" sur la Valserine (Ain).* J. Dor. (33) Sept. 16.
Der Neubau der Röntgenbrück in Charlottenburg.* Zangemeister. (49) Pt. 7.
Was kennt man im Auslande von dem Brückenbau in Russland?* (52) Aug. 31.
Unterführung aus Stampfbeton.* Kupfer. (78) Sept. 13.
Der Ideen-Wettbewerb zur Erlangung von Entwürfen für den Neubau der Kaiserbrücke über die Weser in Bremen.* Th. Landsberg. (48) Serial beginning Sept. 23.

Electrical.

An Improved Absorption Dynamometer.* C. M. Garland. (55) Vol. 32.
Economy of the Electric Drive in the Machine Shop. A. L. De Leeuw. (55) Vol. 32.
Economical Features of Electric Motor Applications.* Charles Robbins. (55) Vol. 32.
A Direct-Reading Instrument for Submarine-Cable and other Calculations. Rollo Appleyard. (63) Vol. 184.
Chemical Action in the Windings of High-Voltage Machines. A. P. M. Fleming and R. Johnson. (77) Aug.
The Non-Salient Pole Turbo-Alternator and its Characteristics.* Stanley P. Smith. (77) Aug.
Battery Economics and Battery Discharge Arrangements.* A. M. Taylor. (77) Aug.
Practical Aspects of Printing Telegraphy.* Donald Murray. (77) Aug.
The Laying and Maintenance of Transmission Cables.* C. Vernier. (77) Aug.
Electricity in Ice Plants.* Aug. C. Smith. (4) Sept.
Automatic Track Circuits.* (26) Sept. 8.
Recent Developments in Radio-Telegraphy.* G. W. O. Howe. (Paper read before the British Assoc.) (73) Sept. 8; (11) Sept. 8.
A New Two- To Three-Phase Transformer.* M. Vidmar. (Abstract from *Elektrotechnik und Maschinenbau.*) (73) Sept. 8.
Electrical Steering.* B. Parker Haigh, Assoc. M. Inst. C. E. (Paper read before the British Assoc.) (11) Sept. 8; (26) Sept. 22; (73) Sept. 15.
Recent Improvements in Single-Phase Motors.* W. A. Layman. (Abstract of paper read before the National Elec. Light Assoc.) (47) Sept. 8.
The Barbour Homopolar Dynamo.* (11) Sept. 8.
New High-Tension Transmission System in Connecticut Valley.* (27) Sept. 9.
Hydroelectric Station at Clinton, Mass.* (27) Sept. 9.
A Steam-Plant Transmission System for Harrison County, Ia., and Washington County, Neb.* W. A. Trussell. (27) Sept. 9.
Variation of Resistance with Temperature Shown by Nernst Glower.* Albert A. Somerville. (27) Sept. 9.
Appraisal of the Chicago Telephone Company and Determination of Fair Rates of Charge. William J. Hagenah. (86) Serial beginning Sept. 13.
Stroboscopic Methods of Measuring the Slip in Induction Motors.* A. Bruckmann. (Abstract from *Elektrotechnische Zeitschrift.*) (73) Sept. 15.
How Electricity is Aiding the Chemist.* (46) Sept. 16.
Overhead-Line Construction. (Paper read by a Committee before the Pennsylvania Elec. Assoc.) (27) Sept. 16.
Georgia's Greatest Power Development.* (27) Sept. 16.
Lightning Arrester Installation of Pittsburgh Railway System.* Terrell Croft. (27) Sept. 16.
Electrical Development in China.* L. R. Freeman. (27) Sept. 16.
The Electric Weigher. E. H. Messiter. (16) Sept. 16.
Power Plant at Gatun, Panama. (62) Sept. 18.
The Trollhättan Hydro-Electric Power-Station, Sweden.* (11) Sept. 22.
An Improved Wireless Telephone Transmitter.* W. Dubilier. (73) Sept. 22.
The Single-Phase Repulsion Motor.* Thomas F. Wall. (Paper read before the British Assoc.) (73) Serial beginning Sept. 22.
Experiments on Spark Gaps with Alternating Current.* W. Weicker. (Abstract from *Elektrotechnische Zeitschrift.*) (73) Sept. 22.

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*Illustrated.

Electrical—(Continued).

Short Cuts in Transmission Line Economics. Alfred Still. (27) Sept. 23.
An Electric Credit System for Department Stores.* A. Lawrence. (27) Sept. 23.
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Electric Drives for Screw Propellers.* H. A. Mavor. (Paper read before the British Assoc.) (73) Sept. 8; (26) Sept. 22.
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The Sperry Gyro-Compass.* (95) Oct.
For Heavier Armor. Sidney G. Koon. (95) Oct.
Le Moteur Diesel à Bord des Navires de Haute Mer.* A. Bochet. (32) July.
Le Yacht à Moteur à Gas Pauvre *Progress*.* (33) Sept. 9.

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The Mechanical Engineer and the Textile Industry.* H. L. Gantt. (55) Vol. 32.
Operating Conditions of Passenger Elevators.* Reginald P. Bolton. (55) Vol. 32.
The Field for Grinding.* C. H. Norton. (55) Vol. 32.
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The Transmission of Heat in Surface Condensation.* George A. Orrok. (55) Vol. 32.
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American Practice in Cleaning Blast Furnace Gas.* Samuel K. Varnes. (98) Aug.
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Engine Testing Brakes.* W. D. Wansbrough. (10) Sept.
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Modern Methods of Steam Production.* Jas. T. Hodgson, Assoc. M. Inst. Mech. E. (21) Serial beginning Sept.

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Principles of Flight. Algernon E. Berriman. (Paper read before the British Assoc.) (11) Sept. 8.
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Calorific Versus Candle-Power Standards. Wilfred Philpot. (Paper read before the Canadian Gas Assoc.) (83) Sept. 15.
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An Aerial Cableway for Handling Coal from Mine to Colliery.* B. Benthaus, M. I. M. E. (13) Sept. 28.
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Suspended Electric Railways for Industrial Service.* J. F. Gairns. (10) Oct.

Power Transmission in Gas Engines.* Horace Allen. (10) Oct.

Gas Power from Low Grade Fuels. R. H. Fernald. (10) Oct.

Modern Hauling Problems. Rollin W. Hutchinson. (10) Oct.

The Internal-Combustion Engine in Modern Practice.* Robert L. Streeter. (9) Oct.

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Filament Ignition of Gas.* Howard Lyon. (Paper read before the Michigan Gas Assoc.) (83) Oct. 2.

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Die Arbeitsmaschinen für die Textilindustrie auf den Ausstellungen zu Turin und Roubaix.* G. Rohn. (48) Serial beginning Sept. 23.

Volumenvergrösserung und Schwindung des Gusseisens.* A. Messerschmitt. (50) Sept. 28.

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The Chemical and Mechanical Relations of Iron, Chromium, and Carbon.* J. O. Arnold and A. A. Read. (71) Vol. 83.

Some Properties of Heat-Treated Three Per Cent. Nickel Steels.* Andrew McWilliam and Ernest J. Barnes. (71) Vol. 83.

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The Influence of Vanadium Upon the Physical Properties of Cast Iron.* W. H. Hatfield. (71) Vol. 83.

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The Magnetic Properties of Some Nickel Steels, with Some Notes on the Structures of Meteoric Iron.* E. Colver-Glauert and S. Hilpert. (71) Vol. 83.

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Specifications for Materials, Aluminum and Copper, Alloys Division of the Standards Committee of the Society of Automobile Engineers, June, 1911. (108) Sept.

Vanadium in Iron and Steel Castings. G. S. Norris. (Paper read before the Am. Foundrymen's Assoc.) (47) Sept. 8.

Carbon Control in Cast Iron. R. Buchanan. (Paper read before the British Foundrymen's Assoc.) (47) Sept. 15.

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The Trolhättan Electric Smeltery.* J. B. Van Brussel. (16) Sept. 30; (105) Oct.

The Preparation and Properties of Metallic Cerium. Alcan Hirsch. (Paper read before the Am. Electrochemical Soc.) (105) Oct.

Electric Furnace Treatment of Nickel Ore and the Development of a Commmercial Process.* Walter Leonard Morrison. (Paper read before the Am. Electrochemical Soc.) (105) Oct.

Titanium in Iron and Steel. Charles V. Slocum. (Paper read before the Am. Electrochemical Soc.) (105) Oct.

Production of Molybdenum Steel in the Electric Furnace.* E. T. Dittus and R. G. Bowman. (Paper read before the Am. Electrochemical Soc.) (105) Oct.

Design of a 30-Ton Electric Induction Furnace.* Albert Hiorth. (Paper read before the Am. Electrochemical Soc.) (105) Oct.

The Determination of Gold and Silver in Copper. Edward F. Kern and Albert A. Heimrod. (105) Oct.

Electric Iron Smelting in Sweden.* Thomas Duncan Robertson. (Paper read before the Am. Electrochemical Soc.) (105) Oct.

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Ueber das Umschmelzen von Ferromangan im elektrischen Ofen und das Arbeiten mit flüssigem Ferromangan.* Felix Schroeder. (50) Sept. 7.

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Coal-Dust Explosions. George S. Rice. (Abstract of *Circular*, U. S. Bur. of Mines.) (22) Sept. 8.

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Low Cost of Mining on Mother Lode.* William G. Devereux. (16) Sept. 16.

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The Puritan Mine: Some Interesting Features in the Equipment of One of the Newer Colorado Coal Mines.* Joseph Watson. (45) Oct.

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Surveying and Sampling Drill Holes.* E. E. White. (Paper read before the Lake Superior Min. Inst.) (45) Oct.; (16) Sept. 23; (86) Oct. 4; (16) Oct. 7.

The Problems of the Nueva Luz Shaft.* Carl Henrich. (16) Oct. 7.

Note sur la Récupération de l'Or dans le Dragage des Alluvions Aurifères en Guyane Française.* L. C. de la Marlière. (32) July.

Les Mines de Fer dans l'Anjou et la Bretagne, l'Exploitation Intensive des Concessions des Environs de Segré (Maine-et-Loire).* S. Brull. (33) Serial beginning Sept. 2.

Miscellaneous.

Clearing Logged-Off Land by the Aid of a Donkey Engine. W. H. Lawrence. (From *Bulletin*, Washington State Agri. College.) (86) Sept. 13.

The Requirements and Theory of the Advertisement or Notice to Bidders on Contracts for Public Works. Jerome Cochran. (13) Sept. 14.

Methods and Cost of Clearing Logged-Off Lands by the Char-Pit Method. H. W. Sparks. (From *Bulletin*, Washington State Agri. College.) (86) Sept. 20.

Variations in the Weather; A Review of Mr. W. Marriott's Tables and Diagrams. Reginald Ryves, Assoc. M. Inst. C. E. (104) Sept. 22.

Some Experiments in Clearing Logged-Off Land with a Stump Burner. W. H. Lawrence. (*Bulletin*, Washington State Agri. College.) (86) Sept. 27.

Effect of the Sun's Heat on Bed Rock at a Dam Site. (14) Sept. 30.

Cost of Alkali Chloride Electrolysis. Victor Engelhardt. (From *Chemiker Zeitung.*) (105) Oct.

Photometry of Large Light Sources.* G. H. Stickney and S. L. E. Rose. (Paper read before the Illuminating Eng. Soc.) (24) Oct. 2.

Remarques Complémentaires sur la Constitution Intérieure du Globe Terrestre.* M. J. Rey. (32) July.

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Road Improvement and Traffic Requirements.* Reginald Ryves, Assoc. M. Inst. C. E. (Paper read before the Irish Road Congress.) (104) Sept. 8.

Town Planning of a Modern City from an Engineer's Point of View. Charles Brownridge, M. Inst. C. E. (Paper read before the Royal Sanitary Inst. Congress.) (104) Serial beginning Sept. 8.

Proposed Standard Specifications for Street Lighting. (66) Sept. 12.

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Standardised Street Widths. J. Nolan. (Abstract of paper read before the National Conference on City Planning.) (104) Sept. 22; (96) Oct. 5.

Test of a Concrete Sidewalk Slab.* (14) Sept. 23.

Causes of Some Failures of Creosoted Wood Block Paving in Chicago.* C. K. Mohler. (13) Sept. 28.

Street Paving in American Cities. Samuel Whinery, M. Am. Soc. C. E. (14) Sept. 30.

Contraction and Expansion of Brick Pavements. Will P. Blair. (Paper read before the Am. Soc. of Mun. Improvements.) (60) Oct.

Notes and Queries on Grouted and Sand-Filled Brick Pavements. Maury Nicholson. (Paper read before the Am. Soc. of Mun. Improvements.) (60) Oct.

Howard Standard Tests for Asphalt Cements for Sheet Asphalt Pavements. J. W. Howard. (Paper read before the Am. Soc. of Mun. Improvements.) (86) Oct. 4.

Importance of Street Paving in City Life. Ira O. Baker. (Paper read before the International Mun. Congress.) (96) Oct. 5.

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The Electrification of Trunk Lines.* L. R. Pomeroy. (55) Vol. 32.

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Handling Locomotives at Terminals. Frederic M. Whyte. (55) Vol. 32.

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The Prospect of State Ownership of Railways in England and in the United States. W. M. Acworth. (88) Aug.

The Controlling Cabin at Hamburg Chief Station. Kühl. (88) Aug.

Relation of Track Fastenings to Creosoted Ties. Hermann von Schrenk. (Paper read before the St. Louis Ry. Club.) (87) Sept.

The Evolution of the Geared Locomotive.* William Fletcher. (10) Sept.

Track Elevation in Chicago.* (87) Sept.

Sand Sidings.* Köpcke. (87) Sept.

Hungarian Locomotives and Their Performances.* (21) Serial beginning Sept.

Reinforced Concrete in Railway Work.* (21) Serial beginning Sept.

Substitutes for Wood Trunking for Railway Signal Conduits. W. K. Sparrow. (Abstract from paper read before the Ry. Signal Assoc.) (87) Sept.

The Origin and Production of "Corrugation" of Tramway Rails.* W. Worby Beaumont. (Paper read before the British Assoc.) (73) Sept. 8; (26) Sept. 15; (12) Sept. 8; (11) Sept. 8.

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The Sullivan Anti-Creeper.* (15) Sept. 15.

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Switching Locomotive Built by Terre Haute, Indianapolis & Eastern.* (17) Sept. 16; (18) Sept. 30.

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AMERICAN SOCIETY OF CIVIL ENGINEERS

INSTITUTED 1852

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RETROGRESSION IN THE TENSILE STRENGTH OF CEMENT.

By J. M. O'Hara, Assoc. M. Am. Soc. C. E.
To be Presented November 15th, 1911.

The Standard Specifications for Portland Cement, adopted by the American Society for Testing Materials, require the minimum tensile strength for briquettes of neat cement, 1 sq. in. in cross-section, to be as follows, and to show no retrogression in strength between 7 and 28 days:

Age.	Strength.
24 hours in moist air	175 lb.
7 days (1 day in moist air, 6 days in water)	500 "
28 " (1 day in moist air, 27 days in water)	600 "

The question the writer proposes for consideration and discussion in this paper is whether a cement which shows high neat strength at 7 days, and little or no increase of strength at 28 days, or even retrogression, is dangerous. Most engineers are inclined to look at

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Note.—These papers are issued before the date set for presentation and discussion. Correspondence is invited from those who cannot be present at the meeting, and may be sent by mail to the Secretary. Discussion, either oral or written, will be published in a subsequent number of *Proceedings*, and, when finally closed, the papers, with discussion in full, will be published in *Transactions*.

In the *Proceedings* of this Society, the Papers and the Discussions on Papers will hereafter be printed so that each will commence on an odd-numbered page. This is done by special request, in order to enable members who wish to do so to separate the Papers and Discussions for filing under various engineering subjects.

such a cement as a doubtful product, and many condemn it. The following is quoted from one author on cement:

> "The following rules for acceptance or rejection of material on the results of the tensile test represent conservative practice:
>
> "At seven (7) days: Hold for twenty-eight (28) days on excessively high neat strength.
>
> "At twenty-eight (28) days: Reject on retrogression in neat strength if there is any other indication of poor quality."

The writer will discuss only the question: Is the retrogression an indication of poor quality? Other indications of poor quality will not be considered.

First, he will examine the principal ingredients of a Portland cement, and, after analysis, will show the relation of each ingredient to the whole, or finished product.

All investigators agree that the essential ingredients of Portland cement are lime (CaO), silica (SiO_2), and alumina (Al_2O_3). The principal factor is the lime, and the more combined lime present in a cement the greater will be its strength. The lime limit is reached when there is more lime than will combine chemically with the silica and alumina. High lime cements usually set slowly but harden rapidly, and reach their maximum strength in a short time.

When the raw materials are brought together in the kiln, some of the lime combines chemically with the silica, forming calcium silicate, and some of it combines with the alumina, forming calcium aluminate. These chemical combinations must take place in definite proportions, a lack of combination making a more or less unsound product, in accordance with the free lime present. In slaking, lime expands, so that an excess of lime, of more than will unite with the silica and alumina, will cause the cement to expand, or "blow," as it is technically termed, and crack.

Next to the lime, the most important constituent is the silica. The true strength and hardening of a Portland cement is due to calcium silicate. The silica should exist entirely in a combined state, and not as quartz sand, in which condition it does not combine with the lime, and is inert in the subsequent reactions. A Portland cement, therefore, should tend toward a composition approximating the proportion: Lime, 76.6% and silica, 26.4%, as lime and silica combine as tricalcic silicate ($3CaO,SiO_2$).

From the following analysis of an average California Portland cement, it will be seen that cements, as made, do not conform to this. Alumina and ferric oxide are always present in considerable quantities.

Analysis of an
Average California Portland Cement.

Lime (CaO)	62.85
Silica (SiO_2)	22.25
Alumina (Al_2O_3)	7.65
Ferric oxide (Fe_2O_3)	3.35
Magnesia (MgO)	0.78
Sulphur trioxide (SO_3)	1.34

The magnesia in a Portland cement is supposed to replace some of the lime, but it does not normally combine with silica or alumina at the clinkering heat used in the manufacture; and in all probability it is an inert and valueless constituent, and is present in an uncombined state.

Some of the alumina is replaced by ferric oxide, and both are considered as producing the same effect. To the calcium aluminates of a cement are ascribed the initial setting properties. A decrease in alumina tends to make a cement set more slowly, while high alumina affects it in the opposite way. The initial tensile strength of the cement is due to the calcium aluminates, but this strength is probably not permanent.

Several compounds of sulphur are present in cement; the chief of these is calcium sulphate. The action of calcium sulphate on cement is to delay the set. For this reason it is always added (in the form of gypsum, or plaster of Paris) to the cement after burning.

All Portland cements show retrogression in the neat strength at some period, usually between 30 and 90 days.

Examples are shown in Tables 1 and 2, taken from the records of the Laboratory of the Southern Pacific Railroad Company, in San Francisco. Table 1 is compiled from tests of Portland cements manufactured in the United States, and Table 2 from tests of Portland cements manufactured in Europe. The figures represent the tensile strength, in pounds per square inch, and the average obtained from three briquettes broken at the indicated age.

TABLE 1.—AMERICAN PORTLANDS.

Laboratory number.	Age.						
	7 days.	1 month.	2 months.	3 months.	6 months.	9 months.	12 months.
324	718	817	878	803	870	880	883
325	817	916	816	801	860	879	926
327	780	883	738	771	840	858	867
340	723	753	754	729	729	741	770
395	779	800	750	801	832	855	889
396	825	884	878	741	741	758	775
Averages..	774	842	802	774	812	828	852

TABLE 2.—EUROPEAN PORTLANDS.

Laboratory number.	Age.						
	7 days.	1 month.	2 months.	3 months.	6 months.	9 months.	12 months.
197	585	667	690	648	645	675	690
240	480	564	728	645	657	671	683
314	672	836	637	654	661	683	696
317	557	663	725	659	667	747	782
354	593	670	655	600	643	653	663
364	581	666	636	612	672	684	706
Averages..	578	678	678	636	658	686	703

The retrogression shown by Tables 1 and 2 is attributed by some authors to the presence of calcium sulphate. Experiments with cements to which no gypsum had been added, and the same cement with the addition of gypsum, do no indicate this. Sulphates in large quantities will cause a higher short-time test, but the small percentage of sulphur trioxide in cements is not harmful.

This retrogression is probably due to the calcium aluminates. The first strength is obtained from the calcium aluminates, as they hydrate quickly, but the permanent strength is due to the calcium silicates, which are much slower in hydrating.

The full tensile strength of the calcium aluminates is reached at one month, when they become more or less inert; at this age the calcium silicates are acting slowly, but are not strong enough to maintain the strain already reached by the calcium aluminates, hence retrogression takes place.

The calcium silicates are constantly increasing in strength for an indefinite period, and gradually pick up the lost strength. Fig. 1 is a graphic description of this action.

DIAGRAM SHOWING ACTION OF CALCIUM ALUMINATES AND SILICATES.

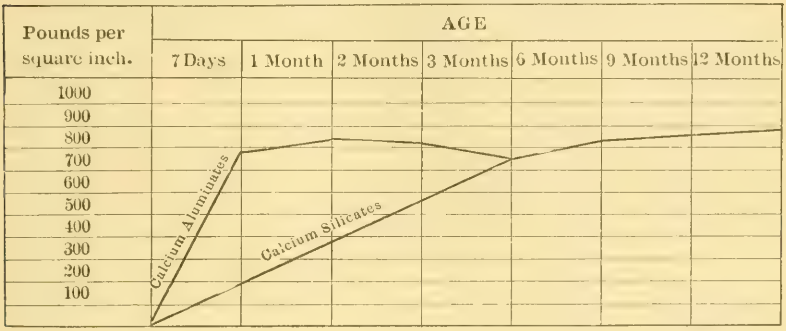

Fig. 1.

If the action of the calcium silicates can be accelerated, so that the final strength is reached sooner, it is an advantage. This is attained, in American Portland cements, by grinding the materials much finer than in former years, and carrying a higher calcium silicate factor. The fine grinding accelerates the hydration of the calcium aluminates and silicates, so that great strength is likely to occur at the 7-day period, and little or no gain, or even retrogression, at the 28-day period.

If the silicates pick up the strength between 1 and 2 months instead of at 6 months, the product is evidently better than the cement that is slow in attaining final strength.

Cements, as manufactured to-day, often show retrogression between 7 and 20 days, and still have an increase in strength between 7 and 28 days.

Generally, there is no retrogression after the 28-day period, which is an indication that the silicates have hydrated rapidly, and permanent strength is reached at 28 days. Table 3 is compiled from tests of cements acting as just stated.

As it is not customary to make the breaks between 7 and 28 days, a cement would undergo retrogression between the periods specified without being detected, and would conform to the specifications.

If this cement is fit for use, why reject one showing retrogression at 28 days?

TABLE 3.—Portlands Showing Early Retrogression.

Laboratory number.	Age.						
	7 days.	10 days.	20 days.	1 month.	2 months.	3 months.	6 months.
515	767	809	792	816	838	867	867
517	736	758	875	844	858	865	868
520	748	802	766	783	801	844	857
522	772	736	732	786	800	826	848
542	686	773	660	770	791	840	851

If retrogression in tensile strength again occurs at a later period, it is only an indication that complete crystallization has taken place, and does not indicate a disrupting action. As crystallization takes place, the cement becomes more and more brittle, and consequently tensile stresses break it more easily.

The fact that the early retrogression in tensile strength is due to calcium aluminates crystallizing quickly, is demonstrated by test pieces in compression, where no retrogression occurs.

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PAPERS AND DISCUSSIONS

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EXPERIMENTS ON THE FLOW OF WATER IN WOOD STAVE PIPES.

By E. A. Moritz, Assoc. M. Am. Soc. C. E.

To be Presented December 6th, 1911.

Introduction.—This paper is a description and discussion of certain experiments on loss of head in wood stave pipes, made under authority of the United States Reclamation Service, on the Sunnyside Project, in the State of Washington. The experiments had their inception in the following circumstance, which shows that necessity is the mother of investigation, as well as of invention:

In the spring of 1908 the writer was called upon to determine the required size of a wood stave pipe to carry water across the Yakima River to irrigate some 9 000 acres of land under the Sunnyside Project. Having had no previous experience in similar calculations, nor any knowledge of actual flow under similar conditions, he was forced to resort to the published data on the subject. These data were rather meager, and consisted of the following, as listed* by Theron A. Noble, M. Am. Soc. C. E.:

Note.—These papers are issued before the date set for presentation and discussion. Correspondence is invited from those who cannot be present at the meeting, and may be sent by mail to the Secretary. Discussion, either oral or written, will be published in a subsequent number of *Proceedings*, and, when finally closed, the papers, with discussion in full, will be published in *Transactions*.

In the *Proceedings* of this Society, the Papers and the Discussions on Papers will hereafter be printed so that each will commence on an odd-numbered page. This is done by special request, in order to enable members who wish to do so to separate the Papers and Discussions for filing under various engineering subjects.

* "Flow of Water in Wood Stave Pipes," *Transactions*, Am. Soc. C. E., Vol. XLIX, p. 134.

"1.—By James D. Schuyler, M. Am. Soc. C. E., on a 30-in. pipe line at Denver, Colo., the details of which are not available. The value of *n,* in Kutter's formula, is given as 0.0096.

"2.—By Mr. Fred B. Gutillius, on the 24-in. pipe of the Butte City Water Company, in which he confirms the use of 0.01 as the value of *n,* in Kutter's formula.

"3.—By Arthur L. Adams, M. Am. Soc. C. E., on an 18-in. pipe for the City of Astoria, Ore. The details of this experiment are given. The results show a value of $n = 0.01$, and $c = 132.9$. Only one observation was taken at a velocity of 3.605 ft. per second.

"4.—By Arthur L. Adams, M. Am. Soc. C. E., on a 14-in. pipe for the West Los Angeles Water Company. In all, there were seven observations, the velocity varying from 0.691 to 1.531 ft. per second; value of *c,* from 99 to 113; value of *n,* about 0.011.

"5.—By Messrs. Marx, Wing and Hoskins, on the 72-in. pipe of the Pioneer Power Plant, at Ogden, Utah. This is by far the most complete and satisfactory set of experiments yet conducted to determine the loss of head in wood pipe. The results have been fully written about and discussed.

"6.—By the writer, on 44-in. pipe, as described in this paper.

"7.—By the writer, on 54-in. pipe, as described in this paper."

These tests are replete with inconsistencies, as brought out in the various discussions on them; and any attempt to co-ordinate the results is apt to be discouraging. On the whole, no well-defined fault was found with any of the published experiments, and this makes an attempt at successful analysis and co-ordination all the more difficult. However, in the above instance, the writer interpreted the results as best he could, and calculated the size of the pipe required for the case in hand.

On the Sunnyside Project of the United States Reclamation Service there are quite a large number of wood stave pipes in service, and the above incident gave the writer the idea that experiments on friction losses in these pipes could be made with very little expense, in connection with the regular hydrographic work on the project, and bade fair to produce valuable information. Accordingly, the idea was suggested to E. McCulloh, M. Am. Soc. C. E., Project Engineer, and met with his instant approval; and it is largely due to his hearty co-operation and unfailing interest that a considerable amount of valuable information has been gathered. The experiments and the reduction of the observations were in direct charge of the writer, who was ably assisted by Mr. J. S. Moore, Junior Engineer, Hydrographer on the Sunnyside Project, to whom a large measure of credit is due, not only for good work performed, but for his many valuable ideas and suggestions in connection with taking and reducing the observations.

The irrigation season on the Sunnyside Project begins on April 1st and ends on September 30th, and the experiments herein described were made during the seasons of 1909 and 1910, principally in the last two months of each season, because at this time a greater variation can be made in the flow of the various pipes without interfering seriously with the process of irrigating. Even at this time it was not possible to vary the flow as much as was desired, on account of the lateral at the intake or outlet not being able to take care of extreme variations in the water supply. However, this difficulty probably had no effect in vitiating the results of the experiments, for it is not likely that the conclusions would have been different had greater variations been possible. As it was, the field of velocities, from 0.4 to 6 ft. per sec., was quite thoroughly explored. All statements made herein must be considered as applying to velocities within these limits.

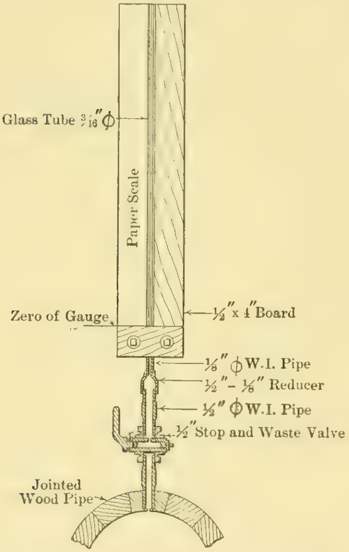
Scope of Tests.—Observations were taken on pipes of the sizes and lengths given in Table 1.

TABLE 1.—SIZES AND LENGTHS OF PIPE.

Year.	Diameter, in inches.	Length, in feet.	Year.	Diameter, in inches.	Length, in feet.
1909	55¾	2 848.2	1910	55¾	2 848.2
"	14	3 637.0	"	22	2 087.0
"	8	3 394.5 and 2 002.0	"	18	2 802.5 and 2 774.2
"	6	500.4	"	14	3 637.0
"	5	1 822.0	"	12	2 022.0
			"	8	3 515.2 and 4 054.9
			"	6	1 801.0 1 892.0 2 021.0
			"	4	1 109.5 and 603.0

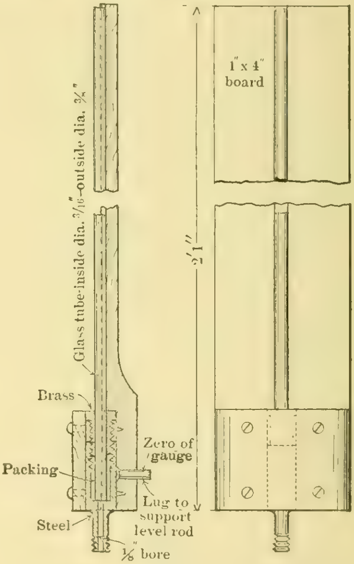
The 55¾-in. pipe is of continuous-stave construction, and the others are of the so-called machine-banded, jointed-stave type, manufactured in usual lengths of from 8 to 20 ft., with mortise and tenon ends, which are driven together in the trench and not otherwise jointed.

The range of velocities was between a minimum of 0.403 ft. per sec. for the 6-in. pipe tested in 1910, and a maximum of 5.874 ft. per sec. for the 8-in. pipe tested in 1910. As has been stated, this range was limited in some cases by the required regulation of irrigation water, but in some cases it was also affected by such items as the difficulty of measuring larger quantities, the presence of air in the pipe, etc. In the 5 and 6-in. pipe this latter difficulty was especially troublesome, and on this account, and because of its short length, it was thought best not to test this 6-in. pipe again, therefore the 1910 experiments were made on a different and longer one. No other 5-in. pipe was available, but the tests on the pipe of that size, made in 1909, were not repeated. Observations made in 1909 were repeated in 1910 on the 55¾, 14, and 8-in. pipes, the identical lengths being used.



WATER GAUGE ATTACHMENT TO WOOD PIPE

Fig. 1.



MANOMETER SCALE

Fig. 2.

Apparatus and Measurements.

Pressure Measurements.—The pressures were measured with water columns for the lower heads and mercury columns for the higher heads, when scaffolding would have been necessary in order to use a water column.

PLATE CXLIII.
PAPERS, AM. SOC. C. E.
OCTOBER, 1911.
MORITZ ON
FLOW OF WATER IN WOOD PIPE.

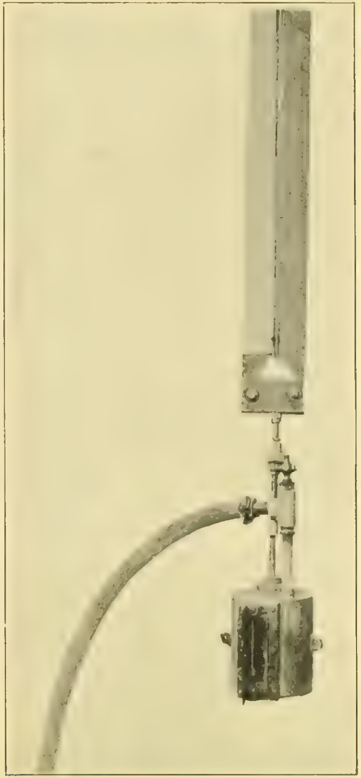


FIG. 1. - SMALL MERCURY RESERVOIR AND GAUGE.

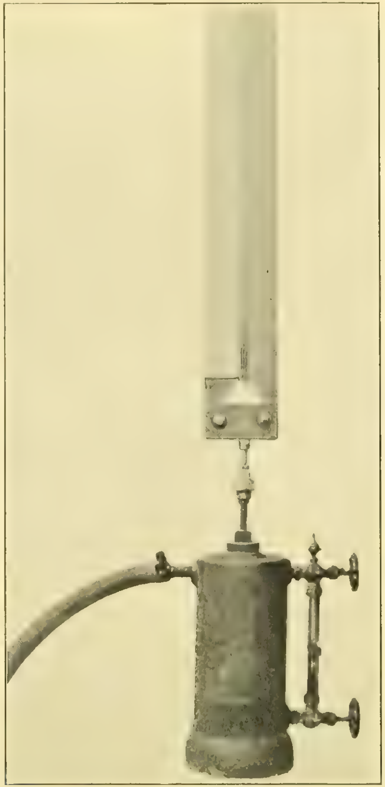


FIG. 2.—LARGE MERCURY RESERVOIR AND GAUGE.

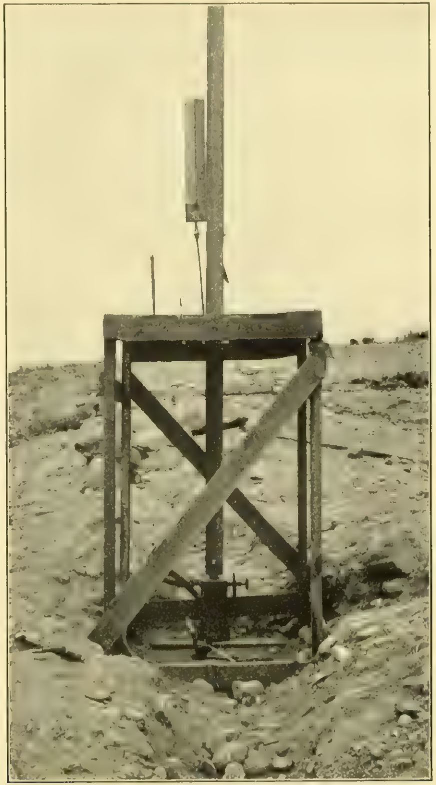


FIG. 3.—MANOMETER NO. 4, ON 55¾-INCH PIPE.

Fig. 1 is a diagram of the water gauge attachment, and requires no explanation. The paper scales on which the heights were observed were graduated to 0.01 ft., and readings were recorded to 0.001 ft. The scale shown in Fig. 1 was used in 1909. This was improved somewhat for the 1910 experiments, as shown in Fig. 2. Setting a level rod on the zero of the gauge, as used at first, was found to be awkward, and, on the later instrument, a lug at the back was provided for this purpose. The graduations were also marked directly on the wood, instead of on a paper glued to the wood. Figs. 1 and 2, Plate CXLIII, show the mercury reservoirs of the two types used. These are the same gauges as Messrs. Marx, Wing, and Hoskins used in their 72-in. pipe experiments,* and were obtained for the tests of these Washington pipes through the courtesy of C. D. Marx, M. Am. Soc. C. E. They were set just as shown on Plate CXLIII, except that, when required for higher pressures, an additional length of ⅛-in. pipe was inserted between the reservoir and the glass gauge. Fig. 3, Plate CXLIII, shows one of the pressure stations on the 55¾-in. pipe. The larger reservoirs, shown in Fig. 2, Plate CXLIII, were used on the 55¾-in. pipe; and, on all the smaller sizes, when a mercury column was necessary, the smaller reservoirs were used. The specific gravity of the commercial mercury in the gauges, was determined by a set of tests made in the physical laboratory of the High School at Sunnyside, Wash., and was found to be 13.58 at 15° cent.; this value was used in all the reductions.

Attachment of Gauges.—The gauges were attached to the pipes by a ½-in. wrought-iron nipple, threaded at both ends and screwed into a hole bored in the wood pipe, in the manner described by Mr. T. A. Noble,† that is, the hole which was to receive the nipple was not bored of full size clear through the pipe, but was stopped as soon as the tip of the bit projected through the inner surface. It is believed that a hole made in this manner is not as likely to have rough edges and projections on the interior surface—which might cause the velocity head to affect the pressure measurements—as a hole of full size bored clear through. The hole at Manometer No. 3, on the 55¾-in. pipe, bored in this manner, was observed from the interior of the pipe and found to be perfectly smooth. The hole at Manometer No. 4 could not be detected from the inside, which makes it reasonable to suppose that the smoothness of the interior surface at the tap was all that could be desired. On account of the small size of all the other pipes, it was impossible to observe the taps from the interior.

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* Described in detail in *Transactions*, Am. Soc. C. E., Vols. XL and XLIV.

† "Flow of Water in Wood Stave Pipes," *Transactions*, Am. Soc. C. E., Vol. XLIX.

All connections were through a single tap at the top of the pipe. For observations at the higher velocities, on the 18-in. pipe, the disturbances due to the pressure of air were so violent that it was found necessary to make the connection at a lower point. This is the only case where the point of connection was varied.

Discharge Measurements.—In all the experiments the quantities were measured over weirs. Those for the 55¾-in. pipe were measured over an 18-ft. rectangular weir with a crest of No. 11 gauge iron. This weir was at the intake of the pipe. Plate CXLIV is a view of the weir and intake, and Fig. 3 is a cross-section. During the 1909 observations there was considerable velocity of approach above the weir. This was estimated by taking eight-tenths of the surface velocity, measured by floats, as the average velocity. In order to determine this velocity of approach more accurately, and with the hope of obtaining a check on the weir formula, measurements of discharge were made for the 1910 observations with a Price current meter. The meter was operated from a bridge across the canal about 75 ft. up stream from the weir. For heads higher than 0.8 ft. over the weir, Smith's formula for contracted weirs agreed very closely with the meter results, but, for all lower heads, no formula seemed to give quantities as high as the current meter. The channel in front of the weir was badly silted up during all the observations, and it was difficult to determine the velocity of approach, especially for the smaller quantities. It has been concluded,

CROSS-SECTION OF INTAKE,
MABTON PRESSURE PIPE

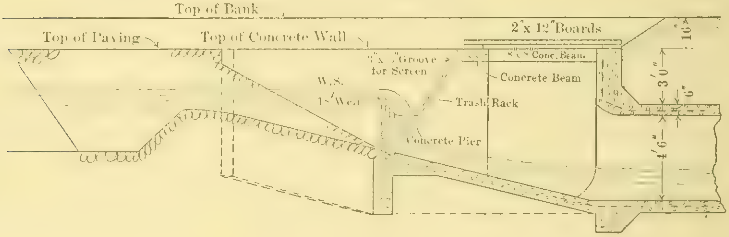
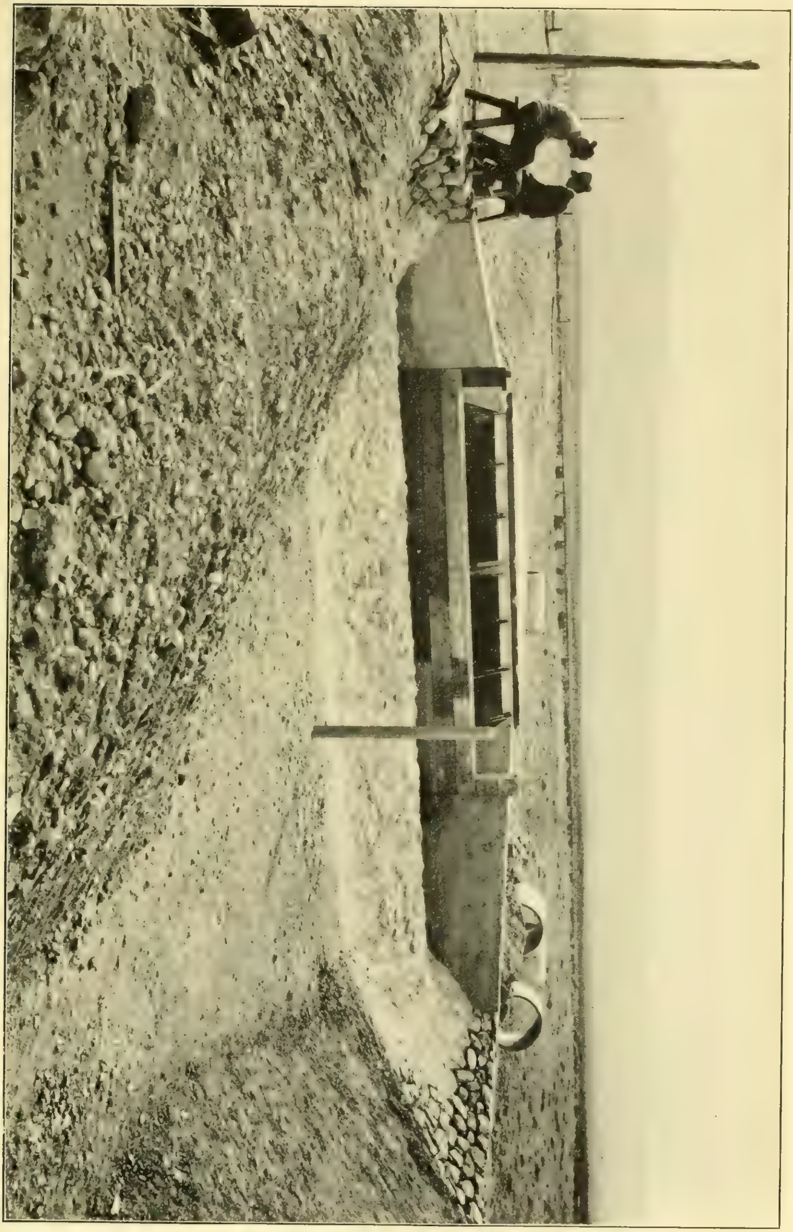


FIG. 3.



INTAKE OF 55¾-INCH PIPE.

therefore, that the current meter measurements are the more reliable, especially in view of the fact that uniformly good results had been obtained previously with the current meter in other channels. The quantities determined by the current meter have been used in the reductions. The discharge curve obtained from the meter results is plotted in Fig. 4, with the observed heads over the weir as ordinates. The curve obtained from the weir measurements, by using Smith's coefficients for contracted weirs and correcting for velocity of approach, is shown by the dashed line in the same figure.

The discharges from all other pipes were measured over Cippoletti weirs. No attempt was made to measure velocities of approach, but care was taken to erect a suitable baffle-wall across the approach channel in all cases when velocity of approach was likely to assume dangerous proportions. Fig. 5 shows a cross-section of the sharp-crested weir most frequently used; in a few cases, however, it was necessary to take the measurements with the weir already in place, a typical cross-section of which is also shown in Fig. 5. The latter was the standard on the Sunnyside Project until about two years ago, and a large number are still in place. For the quantities measured over these weirs, reductions were made on the basis of a series of volumetric tests made on the Sunnyside Project by John C. Stevens, Assoc. M. Am. Soc. C. E.* For Observations 1 and 2 on the 22-in. pipe, it was necessary to use an 8-ft. weir of this same construction, and for these

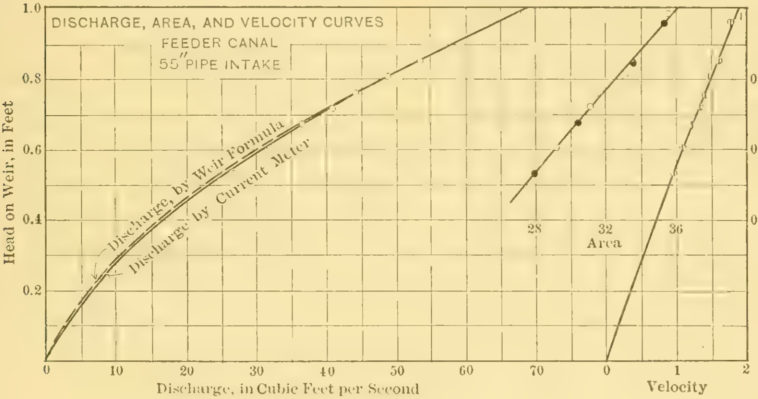


FIG. 4.

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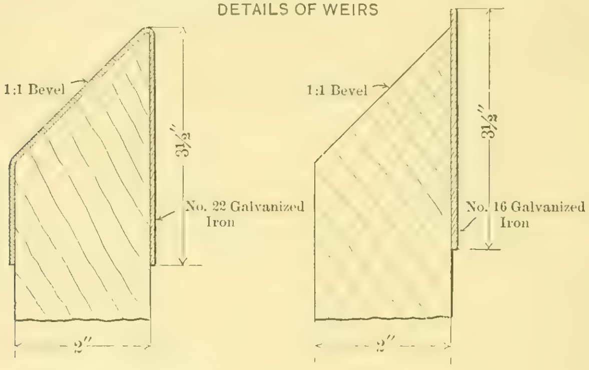
* *Engineering News*, Vol. 64, p. 171.

an addition of 2% to the discharge was considered to be a reasonable value. For the 6-in. pipe tested in 1909, a similar weir with a crest length of 1 ft. was used, but the quantities were derived from a comparison of discharge previously measured during the observations on the 5-in. pipe between a 1-ft. weir of this type at the intake and a sharp-crested one at the outlet. On account of the abnormal condition of these crests, the result obtained from this comparison is probably nearer the true value of the discharge than that determined by a comparison with the volumetric measurements previously mentioned. With the exceptions just mentioned, all pipes were equipped with sharp-crested weirs, reduction to discharge being made directly from the Cippoletti formula, $Q = 3.37\ L\ H^{\frac{3}{2}}$. In all cases, except for the tests made in 1909 on the 14-in. pipe, the heads were measured with a hook-gauge, on which the readings were taken to the nearest thousandth of a foot.



Round-Crested Weir

Sharp-Crested Weir

Fig. 5.

Elevation and Distance.—The difference in elevation between zeros of gauges was determined with a wye-level. A closed circuit was run in every case, and when apparent discrepancies or inconsistencies were encountered, which might have been attributed to errors in elevations, the circuit was repeated, but in no cases were the levels found to be in error. The limit placed on the error of closure was

$$0.01\ \sqrt{\text{Distance, in Miles}},$$

and the average error of closure for all pipes experimented on was

$$0.005\ \sqrt{\text{Distance, in Miles}}.$$

Distances were measured with a 100-ft. steel tape.

OBSERVATIONS.

Plan.—During a test observers were stationed at each manometer and at the intake. Most of the pipes are in open and gradually sloping country, and each observer was able to see the others, either with the naked eye or with a field-glass, so that it was possible to signal back and forth at will. After all the measuring apparatus had been properly attached and tested, and the flow into the pipe approximately adjusted to a desired quantity, some time was allowed—usually about ½ hour—for the flow to become steady, as indicated by the action of the gauges. Sometimes, due to various causes, a much longer time than this was required before a consistent set of readings could be obtained, and especial care was always taken to make sure that the flow was not under the influence of abnormal conditions. Each test lasted 30 min., during which time the pressure gauges were read at intervals of 1½ min. The gauges nearly always fluctuated slightly, and the maximum, minimum, and average readings were recorded. For each test, therefore, sixty gauge readings were recorded for each manometer. The valve between the pipe and the gauge was always closed down until the fluctuations of the column were almost entirely destroyed, but not enough to involve any danger of shutting off the connection entirely. Thus the fluctuation of the column was reduced to such an extent that the greatest normal vibration was about 0.003 ft., except in the 55¾-in. pipe, where the fluctuations at times were somewhat higher, but never more than 0.006 ft. Greater fluctuations were observed in several cases, but were caused by the presence of air, which was a source of some annoyance in the smaller pipes. In using a water column connected to the top of the pipe, it was practically impossible to read the instruments when any appreciable quantity of air was being carried. When such conditions arose, the test was stopped and steps were taken to prevent air from entering the pipe, no further readings being taken until this source of disturbance was overcome.

Reductions of Observations.—As has been stated, the discharges of the 55¾-in. pipe were measured with a current meter in an earth channel. The reduction of these observations requires no further comment. The manner of reducing the discharges of the other pipes, and the various corrections applied, have also been explained. A brief description of the manner of reducing the gauge readings may be of value in interpreting the tabulations:

On account of the comparatively large loss of head in the smaller pipes, it was found to be an unnecessary refinement to apply temperature corrections to the gauge readings; consequently, their reduction to pressure at the station was a simple matter. For the water gauges, the zero of the glass scale was taken as a convenient datum, and the pressure above this point was then equal to the reading of the gauge. For the mercury gauges, the zero of the lower scale on the reservoir was taken as the datum, and the water pressure was then obtained by subtracting the reading of the lower scale from the height of the upper mercury surface above the assumed datum, multiplying this by 13.58, and adding to this product the reading of the lower scale. The pressure, in feet of water, thus obtained, added to the elevation of the assumed datum gave the elevation of the hydraulic gradient at the station. Having obtained this quantity at two stations on the pipe, the loss of head between them was obviously the difference between these two elevations.

For the 55¾-in. pipe, the total loss of head between the two observation stations was so small, and the difference in length of the two mercury columns was so great, that temperature corrections were desirable.

When the experiments on the 55¾-in. pipe were begun the temperature of the water was about 15° cent., and this was chosen as the standard for the two sets of experiments on this pipe. The reduction to this standard temperature was made by multiplying by the factor, $1 - 0.00018\ (T - 15)$, T being the temperature of the mercury column, in degrees, centigrade, and 0.00018 being the average value of the coefficient of expansion of mercury for all temperatures found in the experiments.

As all the mercury columns were standardized to a constant temperature of 15° cent., any departure in the water temperature from the standard also had to be taken into account. This reduction in the mercury column was made by applying the factor, $1 + 0.00015\ (t - 15)$, t being the temperature of the water in the pipe, in degrees, centigrade, and 0.00015 being the value of the coefficient of expansion of water in the neighborhood of 15° cent. The correction for the mercury temperature is negative, while that for the water temperature is positive.

The method of applying the temperature correction may be explained by reference to a single observation, as No. 4, of the 1910 series in Table 2: The actual length of the mercury column at Manometer No. 4 was 7.418; mercury temperature, 13° cent.; water temperature, 11° cent. To reduce to an equivalent column at 15° cent., there must be added $7.418 \times 0.00018 \times 2 = 0.0027$ ft. The correction for water temperature was $7.418 \times 0.00015 \times 4 = 0.0044$ ft. Hence the reduced height of the mercury column was $7.418 + 0.0027 - 0.0044 = 7.4163$.

DESCRIPTION OF PIPES, AND RESULTS OF OBSERVATIONS.

$55\frac{3}{4}$-In. Pipe.—This is a continuous wood stave pipe, built by the Reclamation Service in 1908. Water was first turned into it for operation in May, 1909, and at the time the first test was made it had been in continuous use for about 5 months. Before the water was turned in, measurements of the diameters were made between Manometers Nos. 3 and 4 (the reach in which losses were determined) at intervals of 200 ft. From these measurements the average area was found to be 16.98 sq. ft., which figure was used in reducing the observations. Four diameters were measured at each point: vertically, horizontally, and at angles of 45 degrees. The shortest diameter measured was $54\frac{1}{16}$ in., in the vertical plane; the longest diameter was $57\frac{3}{8}$ in., in the horizontal plane. Fig. 6 is a profile of the areas. The measurements were made before the pipe was put into active service, and before the wood had had a chance to obtain its ultimate swelling.

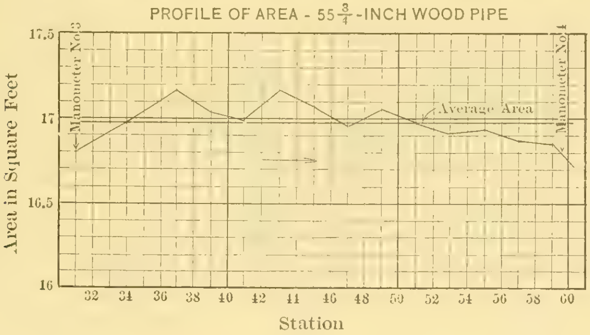


FIG. 6.

To avoid the possibility of any errors in the reductions, due to a change in area after these measurements were made, they were repeated at the completion of the experiments. Corresponding diameters were measured at the same stations, and were found to be equal to the first measurements to the nearest $\frac{1}{16}$ in. This is very surprising, as the pipe had been in service for two years.

Figs. 7 and 8 show, respectively, the alignment and profile of the pipe. The manometers on which observations were made in these experiments are Nos. 3 and 4. The figures show clearly that the conditions were very favorable for good results in this reach. There is no horizontal curve or obstruction of any kind between the two stations, and the vertical curves are light. It will also be noted, from Fig. 6, that the areas at the two manometers were almost exactly equal, thus precluding any error due to inequality of areas at the manometer stations. The various exhibits connected with the experiments on this pipe are shown in Fig. 3, Plate CXLIII, Plate CXLIV, Figs. 3, 4, 6, 7, 8, and 12, and Table 2. The table is self-explanatory, and presents a fairly complete account of the observations and the results deduced therefrom. The value of Kutter's coefficient, n, has been calculated for each experiment, and is given in the last column.

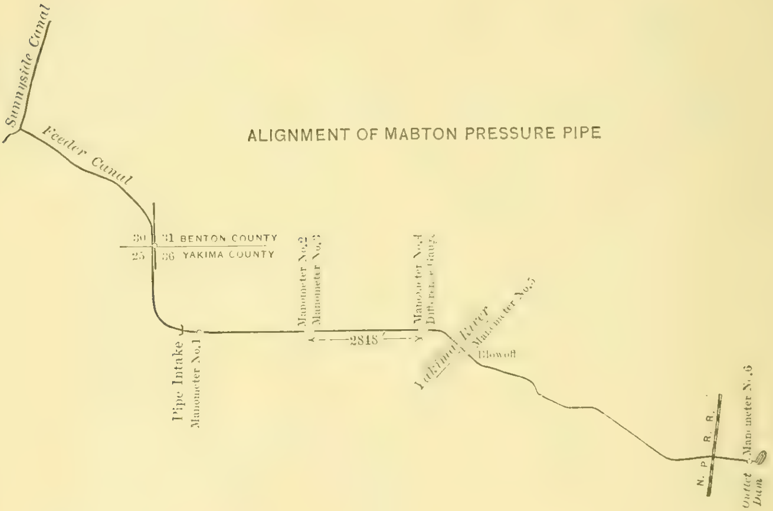

ALIGNMENT OF MABTON PRESSURE PIPE

FIG. 7.

The relation between the velocity in the pipe and the calculated value of n is shown in Fig. 12.

The condition of the $55\frac{3}{4}$-in. pipe at the time of the experiments may be partly inferred from the statements in reference to the cross-sectional areas. The pipe was new, well rounded out during construction, and contained only minor distortions. There was no deposit of any kind in the bottom, and no growth of any kind on the interior surface; in fact, the interior seemed to be in as good condition after the experiments as the day it was built. These points were determined by a thorough inspection of every foot of the interior between Manometers Nos. 3 and 4, both before and after the experiments were made.

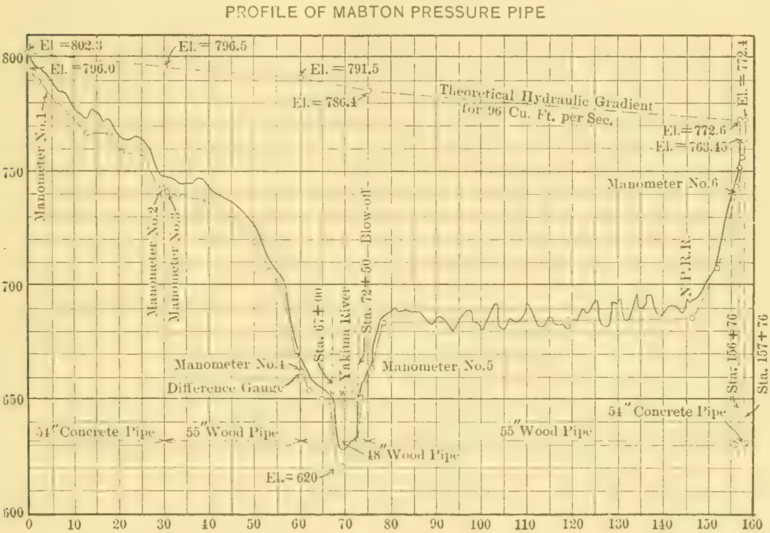


FIG. 8.

22-In. Jointed Wood Stave Pipe.—This pipe was built in 1906 by the Washington Irrigation Company, and has been in use for four irrigation seasons of 7 months each. During the other 5 months of each season no water was run through it, and it was probably almost, if not entirely, empty during most of this period, as it had several small leaks. The normal quantity discharged during the period of operation was about 9 cu. ft. per sec., corresponding to a velocity of

TABLE 2.—OBSERVED AND CALCULATED DATA

No.	Date.	Head on 18-ft. weir.	Discharge from rating table, c. f. s.	MERCURY GAUGE NO. 3.									
				C.	U.	L.	Mercury.	T° cent.	t° cent.	Mercury reduc.	Water equivalent.	Elev. of "L" zero.	Elev. of water column.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	1909												
1	Oct. 5	0.8550	53.40	1.443	0.590	0.195	1.838	15	11	1.8370	25.141	747.368	772.509
2	Oct. 5	0.8315	51.05	1.443	0.515	0.195	1.767	21	15	1.7650	24.164	747.368	771.532
3	Oct. 5	0.7580	44.32	1.443	0.483	0.195	1.731	17	11	1.7290	23.675	747.368	771.043
4	Oct. 6	0.6825	37.60	1.443	0.435	0.195	1.683	20	11	1.6805	23.016	747.368	770.384
5	Oct. 6	0.5975	30.80	1.443	0.410	0.195	1.658	25	13	1.6545	22.663	747.368	770.031
	1910												
1	Oct. 25	0.8520	52.10	1.093	0.879	0.102	1.870	27	14.5	1.866	25.442	749.066	774.508
2	Oct. 25	0.9850	66.85	1.093	0.896	0.102	1.887	22	15	1.885	25.700	749.066	774.766
3	Oct. 26	0.9620	64.32	1.093	0.849	0.102	1.840	5	6	1.841	25.103	749.066	774.169
4	Oct. 26	0.9075	57.98	1.093	1.001	0.102	1.992	13	11	1.992	27.153	749.066	776.219
5	Oct. 26	0.7200	40.90	1.093	0.774	0.102	1.765	19	13	1.763	24.044	749.066	773.110
6	Oct. 26	0.8080	48.82	1.093	0.809	0.102	1.800	12	10	1.800	24.546	749.066	773.612
7	Nov. 1	0.6055	31.44	0.880	0.791	0.103	1.568	17	13	1.567	21.383	749.055	770.438
8	Nov. 2	0.5300	25.70	0.880	0.662	0.103	1.439	10	5.5	1.428	19.641	749.055	768.696
9	Nov. 2	0.4695	21.46	0.880	0.430	0.103	1.207	13	7	1.206	16.480	749.055	765.535

3.5 ft. per sec., but, at the time the tests were made, it was not possible to make provision for carrying more than 8 cu. ft. per sec.

No recorded data are available in regard to the alignment or profile. Observations in the field indicated that the alignment consisted of two tangents making an angle of about 5 degrees. The pipe drops about 75 ft. below the hydraulic gradient at its lowest point, and there it has quite a sharp vertical curve. Levels run over the approximate location of the pipe indicate no summits in the ground, and, as it was supposed to be buried uniformly 2 ft. below the surface, it is probable that it has no summits. Four irrigation hydrants are attached to the pipe, and these may have some effect in roughening the interior surface, but as to this there is no definite knowledge. Nothing is known as to conditions at the time of construction. Measurements of the diameter at the intake and outlet gave an average of 22 in. The pipe seems to have been warped out of shape about 1 in.

Water columns were used for both gauges. The quantities for Observations 1 and 2 were measured over an 8-ft. round-crested weir, those for the remaining observations were measured over a 4-ft. sharp-crested weir. There were seven small leaks, approximately within the first two-thirds of the distance between the gauges. These

ON 55¾-INCH CONTINUOUS WOOD STAVE PIPE.

	Mercury Gauge No. 4.									Loss of Head.				
C. (15)	*U.* (16)	*L.* (17)	Mercury. (18)	T° cent. (19)	t° cent. (20)	Mercury reduc. (21)	Water equivalent. (22)	Elev. of "L" zero. (23)	Elev. of water column (24)	Length, 2 848.2 ft. (25)	Per 1 000 ft. (26)	Area. (27)	Velocity. (28)	*n.* (29)
6.686	0.668	0.200	7.154	15	11	7.150	97.297	674.130	771.427	1.082	0.380	16.98	3.145	0.01051
6.686	0.606	0.200	7.092	22	15	7.083	96.387	674.130	770.517	1.015	0.356	16.98	3.006	0.01062
6.686	0.588	0.200	7.074	18	11	7.066	96.156	674.130	770.286	0.759	0.266	16.98	2.610	0.01053
6.686	0.555	0.200	7.041	20	11	7.030	95.667	674.130	769.797	0.587	0.206	16.98	2.214	0.01083
6.686	0.545	0.200	7.031	25	13	7.016	95.477	674.130	769.607	0.424	0.149	16.98	1.814	0.01109
6.182	1.322	0.180	7.324	27	14.5	7.308	99.423	673.954	773.377	1.131	0.397	16.98	3.068	0.01098
6.182	1.291	0.180	7.293	22	15	7.284	99.097	673.954	773.051	1.715	0.602	16.98	3.937	0.01062
6.182	1.239	0.180	7.241	5	6	7.244	98.554	673.954	772.508	1.661	0.583	16.98	3.788	0.01084
6.182	1.416	0.180	7.418	13	11	7.416	100.889	673.954	774.843	1.376	0.485	16.98	3.415	0.01092
6.182	1.240	0.180	7.242	19	13	7.234	98.418	673.954	772.372	0.738	0.259	16.98	2.409	0.01118
6.182	1.252	0.180	7.254	12	10	7.252	98.662	673.954	772.616	0.996	0.350	16.98	2.875	0.01097
5.935	1.295	0.166	7.064	17	13	7.059	96.027	673.947	769.974	0.464	0.163	16.98	1.872	0.01137
5.935	1.176	0.166	6.945	10	5.5	6.941	94.425	673.947	768.372	0.324	0.114	16.98	1.513	0.01147
5.935	0.951	0.166	6.720	13	7	6.714	91.342	673.947	765.289	0.246	0.086	16.98	1.264	0.01173

were measured volumetrically several times during the series of observations, and the correction to the measured quantity for this loss was assumed to be two-thirds of the total. In addition to these leaks between the gauges, a small leak was purposely maintained from the top of the pipe above Gauge No. 1 in order to release the small bubbles produced by the impact of the free flow down the pipe upon the main body of water under pressure. These small bubbles, unless released, rose slowly through the water column and vitiated the gauge readings.

There has been constant trouble with leaks on this pipe, due to defective material and workmanship, and frequent repairs have been made. It is entirely possible, therefore, that the interior surface is in bad condition; however, no definite information is available, as examination of the interior was impracticable. Table 3 gives the results of these experiments.

18-In. Jointed Wood Stave Pipe.—This pipe was built in 1908, and has been in operation two seasons. The normal velocity maintained during this time was about 3.7 ft. per sec. Quantities were measured over a 6-ft. Cippoletti weir at the outlet of the pipe. A leak in one of the gates in the outlet structure necessitated an additional measurement of quantity over a 1-ft. weir. The alignment includes

TABLE 3.—OBSERVED AND CALCULATED DATA ON 22-INCH JOINTED WOOD STAVE PIPE.

No.	Date, 1910.	Head on 8-ft. weir.	Head on 4-ft. weir.	Discharge, by Cippoletti formula, c. f. s.	LEAKAGE BETWEEN GAUGES.		Leakage above Gauge No. 1, c. f. s.	Total correction for leakage.	Net discharge, c. f. s.	WATER GAUGE No. 1.			WATER GAUGE No. 2.			LOSS OF HEAD.		Area.	Velocity.	*n*.
					Total, c. f. s.	Correction, †c. f. s.				Average of readings.	Elevation of zero.	Elevation of water column	Average of readings.	Elevation of zero.	Elevation of water column.	Total length, 2 087 ft.	Per 1 000 ft.			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)
1	Sept. 23	0.4345	......	*7.864	0.0675	0.045	0.016	0.061	7.803	0.436	101.773	102.209	0.910	97.572	98.482	3.727	1.786	2.64	2.956	0.01263
2	Sept. 23	0.4510	......	*8.320	0.0675	0.045	0.016	0.061	8.259	0.979	101.773	102.752	0.970	97.572	98.542	4.210	2.017	2.64	3.128	0.01267
3	Sept. 24	......	0.4935	4.669	0.1260	0.084	0.016	0.100	4.569	1.581	97.487	99.068	0.470	97.572	98.042	1.026	0.492	2.64	1.731	0.01136
4	Sept. 27	......	0.5050	4.830	0.1570	0.105	0.016	0.121	4.709	1.293	101.743	103.036	1.124	100.626	101.750	1.286	0.616	2.64	1.784	0.01220
5	Sept. 27	......	0.4227	3.705	0.1570	0.105	0.015	0.120	3.585	1.505	101.743	103.248	0.892	101.630	102.522	0.726	0.348	2.64	1.358	0.01192
6	Sept. 27	......	0.3570	2.874	0.1570	0.105	0.016	0.121	2.753	1.300	101.743	103.043	1.049	101.630	102.679	0.364	0.174	2.64	1.043	0.01084
7	Sept. 27	......	0.2740	1.934	0.1570	0.105	0.016	0.121	1.813	1.585	101.743	103.328	0.457	102.724	103.181	0.147	0.070	2.64	0.687	0.00988

* The discharge by Cippoletti formula is increased 2% to correct for the use of a round-crested weir.

† The value for leakage correction between gauges is assumed to be two-thirds of the total leakage occurring in the first two-thirds of the length.

one light curve. The alignment, and the profile of the surface over the pipe are shown in Fig. 9. The top of the pipe is generally 18 in. below the surface, except at the summits, where it is deeper. Measurements of the diameter at the outlet gave an average of 18 in., the pipe being distorted about ½ in. at this point. The intake has a funnel attachment, thus making a measurement of the diameter at this point impracticable.

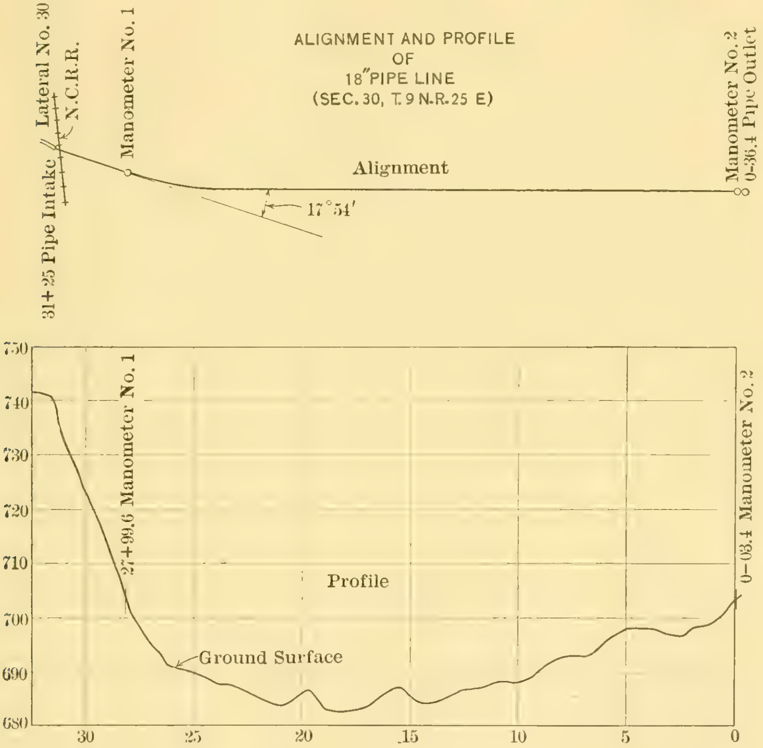


FIG. 9.

Water columns were used at both instruments. As previously stated, Gauge No. 1 was connected to the side of the pipe, the accumulation of air not permitting an attachment to the top. Though Gauge No. 2 was connected directly to the top of the pipe, it exhibited no signs of air disturbance at any time during the observations. For this reason it is hardly possible that any air was carried through the entire length of the pipe. From the regular intervals at which the

TABLE 4.—OBSERVED AND CALCULATED DATA ON 18-INCH JOINTED WOOD STAVE PIPE.

No.	Date, 1910.	Head on 6-ft. weir.	Discharge by Cippoletti formula, c. f. s.	Head on 1-ft. weir.	Discharge by Cippoletti formula, c. f. s.	Total disch. c. f. s.	WATER GAUGE No. 1.			WATER GAUGE No. 2. Elev. of zero, 98.271.		Loss of head.	Length of pipe.	Loss per 1 000 ft.	Area.	Velocity.	n.
							Aver. of readings.	Elev. of zero.	Elev. of water column.	Aver. of readings.	Elev. of water column.						
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
1	Oct. 11	0.4450	6.000	0.052	0.040	6.040	1.179	103 541	104.720	1.122	99.393	5.327	2 802.5	1.901	1 767	3.418	0.01023
2	Oct. 12	0 3920	4.958	0.052	0.040	4.998	0.555	102.527	103.082	1.058	99.329	3.753	2 802.5	1.339	1.767	2.829	0.01032
3	Oct. 12	0.3304	3.837	0.052	0.040	3.877	0.512	101.289	101.801	1.001	99.272	2.529	2 802.5	0.902	1.767	2.194	0.01076
4	Oct. 13	0.2448	2.452	0.031	0.019	2.471	0.473	99.750	100.223	0.893	99.164	1.059	2 774.2	0.382	1.767	1.398	0.01076
5	Oct. 13	0.1918	1.737	0.031	0.019	1.756	1.180	98.522	99.702	0.842	99.113	0.589	2 774.2	0.212	1.767	0.994	0.01093
6	Oct. 13	0.1719	1.443	0.031	0.019	1.462	1.002	98.522	99.524	0.824	99.095	0.429	2 774.2	0.155	1.767	0.827	0.01098
7	Oct. 13	0.1568	1.252	0.031	0.019	1.271	0.909	98.522	99.431	0.810	99.081	0.350	2 774.2	0.126	1.767	0.719	0.01115
8	Oct. 13	0.1290	0.939	0.031	0.019	0.958	0.735	98.522	99.257	0.782	99.053	0.204	2 774.2	0.074	1.767	0.542	0.01080

most violent fluctuations took place, it seemed as though the air was carried only a short distance below Gauge No. 1 and remained there until a sufficient quantity had collected to force itself back up the pipe. Table 4 gives the results of the experiments; and Fig. 13 shows the relation of n to the velocity.

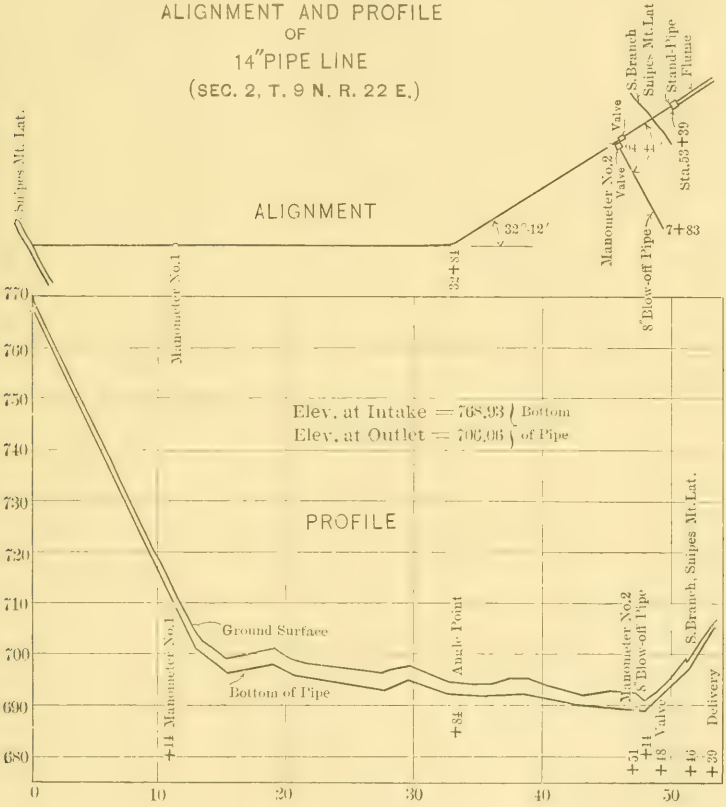


FIG. 10.

14-In. Jointed Wood Stave Pipe.—This pipe was built in 1905, and has been in use five seasons. Measurements at the intake showed an average diameter of 14 in. During the experiments a piece of rotten stave was blown out of the top by the increased pressure, and this afforded an opening through which an additional measurement of the diameter was taken. This also showed an average of 14 in., the distortion being about $\frac{1}{4}$ in. There was no growth of any kind on the interior surface at this point, but there was evidence of considerable wear on the staves. The softer portions of the fir lumber had been worn down, leaving the harder parts to form small ridges approximately parallel to the axis of the pipe. This was the only place affording access to the interior, therefore it is not known that this condition obtained at other points. In any case, its effect on the friction losses would be difficult to predict. The approximate alignment and profile are shown in Fig. 10. The bend of 32° 12′ is made with a series of short sections of pipe, and is not as sharp as indicated in the diagram. The line representing the bottom of the pipe is conjectural for most of the distance, the only known points being one near the intake and one at each manometer. It is possible that the three summits shown do not exist, but, aside from this, the grade could not differ much. It will be noted that the manometers were located very favorably, as they were entirely free from any effect of either vertical or horizontal curvature.

Experiments were made on this pipe in 1909 and 1910, both sets on the same lengths, and with the gauges at the same points. Mercury gauges only were used. In 1909 the quantities were measured over a round-crested weir at the intake, the heads over the weir being taken with a 2-ft. rule. There was considerable disturbance in the weir box for the larger quantities, and before the experiments were begun in 1910 a better baffle-wall was inserted and a sharp crest placed on the weir. The heads were also measured with a hook-gauge in a stilling box. There was a small leak just above Gauge No. 1. This was measured volumetrically several times during the tests, and found to be almost constant at 0.03 cu. ft. per sec. This quantity is subtracted from the discharge measured at the intake. Table 5 gives the results of these experiments. The losses found in 1910 are smaller by about 3% than those found in 1909. The reasons for this can only be conjectured. It is possible that the pipe had become smoother, and it is also possible that some of the difference, if not all, is due to errors of observation. If the latter is true, then more weight should attach to the 1910 experiments, as the facilities for accurate measurements for these tests were better than for those of 1909. It is not probable that there was any silt deposit in the pipe at any time, as the normal velocity during the time of operation was about 2.75 ft. per sec.

12-In. Jointed Wood Stave Pipe.—This pipe was built in 1910,

TABLE 5.—OBSERVED AND CALCULATED DATA ON 14-INCH JOINTED WOOD STAVE PIPE.

No.	Date.	Head on 2-ft. weir.	Discharge, in cubic feet per second.	Mercury Gauge No. 1.							Mercury Gauge No. 2.							Loss of Head.		Area.	Velocity.	*n*.
				C.	U.	L.	Mercury.	Water equivalent.	Elev. of "L" zero.	Elev. of water col.	C.	U.	L.	Mercury.	Water equivalent.	Elev. of "L" zero.	Elev. of water col.	Length, 3 637 ft.	Per 1 000 ft.			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)
	1909																					
1	Oct. 2.	0.1740	0.529*	1.053	0.164	0.073	1.144	15.609	98.036	113.645	1.051	1.664	0.248	2.467	33.750	79.511	113.261	0.384	0.106	1.069	0.495	0.01180
2	Oct. 7.	0.6170	3.493*	1.053	0.160	0.073	1.140	15.554	98.036	113.590	1.051	1.000	0.248	1.803	24.733	79.511	104.244	9.346	2.570	1.069	3.267	0.01038
3	Oct. 7.	0.5400	2.820*	1.053	0.142	0.073	1.122	15.310	98.036	113.346	1.051	1.159	0.248	1.962	26.892	79.511	106.403	6.943	1.909	1.069	2.638	0.01091
4	Oct. 7.	0.4635	2.224*	1.053	0.229	0.073	1.209	16.491	98.036	114.527	1.051	1.426	0.248	2.229	30.518	79.511	110.029	4.498	1.237	1.069	2.080	0.01105
5	Oct. 7.	0.3360	1.752*	1.053	0.391	0.073	1.371	18.691	98.036	116.727	1.051	1.713	0.247	2.517	34.428	79.511	113.939	2.788	0.767	1.069	1.639	0.01097
6	Oct. 8.	0.3230	1.298*	1.053	0.338	0.073	1.318	17.971	98.036	116.007	1.051	1.738	0.247	2.542	34.767	79.511	114.278	1.729	0.475	1.069	1.214	0.01138
7	Oct. 8.	0.2810	1.050*	1.053	0.288	0.073	1.268	17.292	98.036	115.328	1.051	1.735	0.247	2.539	34.727	79.511	114.238	1.090	0.300	1.069	0.982	0.01106
8	Oct. 8.	0.1800	0.555*	1.053	0.277	0.073	1.257	17.143	98.036	115.179	1.051	1.768	0.241	2.578	35.250	79.511	114.761	0.418	0.115	1.069	0.519	0.01182
	1910																					
1	Aug. 25.	0.4705	2.144+	1.039	0.332	0.076	1.295	17.662	98.477	116.139	1.882	0.658	0.076	2.464	33.537	78.598	112.135	4.004	1.101	1.069	2.006	0.01084
2	Aug. 25.	0.4135	1.761+	1.039	0.380	0.076	1.343	18.314	98.477	116.791	1.882	0.799	0.076	2.605	35.452	78.598	114.050	2.741	0.754	1.069	1.647	0.01085
3	Aug. 26.	0.3540	1.384+	1.039	0.488	0.076	1.451	19.781	98.477	118.258	1.882	0.981	0.076	2.787	37.923	78.598	116.521	1.737	0.478	1.069	1.295	0.01085
4	Aug. 26.	0.2950	1.050+	1.039	0.511	0.076	1.474	20.093	98.477	118.570	1.882	1.056	0.076	2.862	38.942	78.598	117.540	1.030	0.283	1.069	0.982	0.01079
5	Aug. 26.	0.2460	0.790+	1.039	0.510	0.076	1.473	20.079	98.477	118.556	1.882	1.085	0.076	2.891	39.336	78.598	117.934	0.622	0.171	1.069	0.739	0.01079
6	Aug. 27.	0.2085	0.612+	1.039	0.345	0.076	1.308	17.839	98.477	116.316	1.882	0.938	0.076	2.744	37.340	78.598	115.938	0.378	0.104	1.069	0.572	0.01046
7	Aug. 29.	0.5640	2.822+	1.032	0.449	0.076	1.405	19.156	98.477	117.633	1.894	0.565	0.076	2.383	32.437	78.598	111.035	6.598	1.814	1.069	2.640	0.01068
8	Sept. 6.	0.4690	2.133+	1.032	0.341	0.076	1.297	17.689	98.477	116.166	1.894	0.657	0.076	2.475	33.686	78.598	112.284	3.882	1.067	1.069	1.995	0.01075

* These quantities are derived from results of volumetric tests by Stevens.

+ This discharge is by the Cippoletti formula, and is reduced by 0.030 cu. ft. per sec. to allow for a leak above Gauge No. 1.

and had been in use about 3 months at the time the observations were made. It was built to supplement the 22-in. pipe already described, and parallels it. The vertical curve at the low point is not as sharp as that of the 22-in. pipe. Measurements of discharge were made over a sharp-crested Cippoletti weir at the intake. A valve at the outlet made it possible to keep the head always above the top of the pipe at the intake, thus eliminating any trouble from suspended air at the instruments. No leaks were observed at any point. Measurements of diameter at the intake gave an average of 12 in., and no distortion was apparent. A water column was used at Gauge No. 1 and a mercury column at Gauge No. 2. The normal velocity, up to the time of the tests, was about 0.8 ft. per sec.

Table 6 shows the results of the experiments. The indicated losses are abnormally high, as compared with the other pipes tested. There is no reason to suppose that this is due to abnormal roughness of the interior surface, although this is a new pipe and may become smoother. The magnitude of the losses and the nature of their variation, in the writer's opinion, do not indicate a rough interior. The writer would rather offer another explanation: The water flowing in this pipe carries quite a large quantity of silt in suspension, and the velocity under which the pipe had been operated up to the time the experiments were made was about 0.8 ft. per sec. It is known from experience that, even at higher velocities than this, such suspended material will deposit, and it would require no large quantity, in a pipe of this size, to reduce the area and correspondingly increase the calculated velocities to such an extent as to affect the apparent relation between velocities and losses of head quite materially. The writer hopes to obtain definite information on this point at an early date.

8-In. Jointed Wood Stave Pipe.—This pipe was built in the spring of 1909, and had been in use about 5 months before the first experiments. Experiments were also made in 1910. In 1909 the observations were taken on lengths of 3 395 and 2 002 ft. A water column was used at the outlet and a mercury column at the other stations. For the 1910 experiments the water column near the outlet was placed in the same position it had occupied in the 1909 tests. The mercury gauge for the first eight observations was placed about 120 ft. above the old location, making the testing length 3 515.2 ft., and for the remaining observations a water gauge was substituted, and the distance between the gauges was increased to 4 054.9 ft.

TABLE 6.—OBSERVED AND CALCULATED DATA ON 12-INCH JOINTED WOOD STAVE PIPE.

No.	Date, 1910.	Head on 4-ft. weir.	Discharge by Cippoletti formula, c. f. s.	GAUGE NO. 1—WATER GAUGE.			GAUGE NO. 2—MERCURY GAUGE. C=0.876 ft. Elev. of "L" zero, 81.947.					LOSS OF HEAD.		Area.	Velocity.	*n*.
				Average of readings.	Elevation of zero.	Elev. of water column.	U.	L.	Mercury.	Water equivalent.	Elev. of water col.	Length, 2 022 ft.	Per 1 000 ft.			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
1	Oct. 8	0.0900	0.360	1.098	97.907	99.005	0.465	0.114	1.227	16.777	98.724	0.281	0.139	0.785	0.459	0.01290
2	Oct. 8	0.1065	0.469	1.238	97.907	99.145	0.463	0.114	1.225	16.750	98.697	0.448	0.222	0.785	0.597	0.01302
3	Oct. 8	0.1230	0.581	1.482	97.907	99.389	0.462	0.114	1.224	16.736	98.683	0.706	0.349	0.785	0.740	0.01404
4	Oct. 8	0.1385	0.698	1.515	97.907	99.422	0.448	0.114	1.210	16.546	98.493	0.929	0.459	0.785	0.889	0.01305
5	Oct. 10	0.1765	0.998	0.476	98.899	99.375	0.391	0.114	1.153	15.772	97.719	1.656	0.819	0.785	1.271	0.01255
6	Oct. 10	0.2000	1.200	0.925	98.899	99.824	0.368	0.114	1.130	15.459	97.406	2.418	1.196	0.785	1.529	0.01267
7	Oct. 10	0.2225	1.415	0.810	98.899	99.709	0.307	0.114	1.069	14.631	96.578	3.131	1.548	0.785	1.803	0.01235

TABLE 7.—Observed and Calculated Data

No	Date.	Meas't at Intake.		Measurement at Outlet.			Average discharge, c. f. s.	Gauge					
								Mercury					
		Head on 2-ft. weir.	Discharge, c. f. s.	Head on 3-ft. weir.	Head on 1-ft. weir.	Discharge, c. f. s.		C.	U.	L.	Mercury.	Water equivalent.	Elev. of "L" zero.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	1909												
1	Sept. 28	0.2640	0.961*	......	.....	......	......	1.055	1.226	0.072	2.209	30.070	100.335
2	Sept. 28	0.1350	0.366*	......	......	......	......	1.055	0.199	0.072	1.182	16.124	100.335
3	Sept. 28	0.1600	0.469*	......	......	......	......	1.055	0.315	0.071	1.299	17.711	100.335
4	Sept. 28	0.1840	0.573*	......	......	......	......	1.055	0.455	0.071	1.439	19.613	100.335
5	Sept. 28	0.2215	0.745*	......	......	......	......	1.055	0.745	0.071	1.729	23.551	100.335
6	Sept. 29	0.2530	0.904*	......	......	......	......	1.055	1.111	0.071	2.095	28.521	100.335
7	Sept. 29	0.2800	1.045*	......	......	......	......	1.055	1.436	0.070	2.421	32.947	100.335
8	Sept. 29	0.3315	1.349*	......	......	......	......	2.064	1.244	0.065	3.243	44.105	100.335
9	Sept. 29	0.3630	1.538*	......	......	......	......	3.067	0.803	0.063	3.807	51.762	100.335
10	Oct. 27	0.1515	0.433*	......	......	......	......	1.105	0.794	0.236	1.663	22.820	80.033
11	Oct. 27	0.2290	0.782*	......	......	......	......	1.105	1.122	0.234	1.993	27.299	80.033
	1910												
1	Sept. 7	0.4480	2.018†	0.3490	......	2.081†	2.050	2.950	1.058	0.077	3.931	53.460	101.392
2	Sept. 8	0.4140	1.794†	0.3180	......	1.812†	1.803	2.950	0.455	0.077	3.328	45.271	101.392
3	Sept. 8	0.3660	1.492†	0.2770	......	1.476†	1.484	1.916	0.740	0.077	2.579	35.100	101.392
4	Sept. 8	0.3400	1.330†	0.2550	......	1.300†	1.315	1.916	0.463	0.076	2.303	31.351	101.392
5	Sept. 9	0.3120	1.172†	0.2370	......	1.166†	1.169	1.027	1.087	0.076	2.038	27.752	101.392
6	Sept. 9	0.2665	0.922†	0.1980	......	0.888†	0.905	1.027	0.693	0.076	1.644	22.402	101.392
7	Sept. 9	0.2340	0.760†	0.1745	......	0.737†	0.748	1.027	0.476	0.076	1.427	19.455	101.392
8	Sept. 9	0.1960	0.584†	0.1460	......	0.566†	0.575	1.027	0.281	0.076	1.232	16.807	101.392
9	Sept. 9	0.1590	0.426†	0.1200	......	0.420†	0.423	......	......	......	......	......	101.392
10	Sept. 10	0.1320	0.326†	......	0.216	0.338†	0.332	......	......	......	......	......	101.392
11	Sept. 10	0.0910	0.183†	......	0.143	0.182†	0.182	......	......	......	......	......	101.392
12	Sept. 10	0.0810	0.153†	......	0.133	0.163†	0.158	......	......	......	......	......	101.392

* These quantities are derived from the results of volumetric tests by Stevens.

Fig. 11 shows the approximate alignment and profile of the pipe, and the favorable location of the manometers. The bend of 16° 40′ is made with a number of short sections, in the same manner as that for the 14-in. pipe, and is not as sharp as indicated. The only known elevations of the pipe are at the manometers and at the intake and outlet, the remainder being estimated.

The discharge in the 1909 experiments was measured at the intake, over a 2-ft. round-crested Cippoletti weir. In 1910 a sharp crest was placed on this weir, and simultaneous measurements were made at the outlet over a 3-ft. sharp-crested weir. For the last three observations, when the head over the 3-ft. weir became too small to afford accurate results, a 1-ft. weir was substituted. All heads were measured with hook-gauges. The value of the discharge used in the reductions is the mean of the quantities measured at the intake and outlet.

ON 8-INCH JOINTED WOOD STAVE PIPE.

No. 1.				Gauge No. 2.								
gauge.	Water gauge.			Water gauge.			Loss of head.	Length of pipe	Loss per 1 000 ft.	Area.	Velocity.	*n*.
Elev. of water col.	Aver. of readings.	Elev. of zero.	Elev. of water col.	Aver. of readings.	Elev. of "L" zero.	Elev. of water col.						
(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)
130.405	......	....	....	0.935	112.925	113.860	16.545	3394.5	4.874	0.349	2.754	0.01101
116.459	......	....	....	0.658	112.925	113.583	2.876	3394.5	0.847	0.349	1.049	0.01159
118.046	......	....	....	0.694	112.925	113.619	4.427	3394.5	1.304	0.349	1.344	0.01140
119.948	......	....	....	0.733	112.925	113.658	6.290	3394.5	1.853	0.349	1.642	0.01123
123.886	......	....	....	0.817	112.925	113.742	10.144	3394.5	2.988	0.349	2.135	0.01107
128.856	......	....	....	0.899	112.925	113.824	15.032	3394.5	4.428	0.349	2.590	0.01112
133.282	......	....	....	0.985	112.925	113.910	19.372	3394.5	5.707	0.349	2.994	0.01098
144.440	......	....	....	1.189	112.925	114.114	30.326	3394.5	8.934	0.349	3.866	0.01074
152.097	......	....	....	1.328	112.925	114.253	37.844	3394.5	11.149	0.349	4.407	0.01057
102.853	......	....	....	0.618	100.004	100.622	2.231	2002.0	1.114	0.349	1.241	0.01138
107.332	......	....	....	0.782	100.004	100.786	6.546	2002.0	3.270	0.349	2.241	0.01105
154.852	......	....	....	1.551	112.896	114.447	40.405	3515.2	11.494	0.349	5.874	0.00859
146.663	......	....	....	1.428	112.896	114.324	32.339	3515.2	9.200	0.349	5.166	0.00871
136.492	......	....	....	1.251	112.896	114.147	22.345	3515.2	6.357	0.349	4.252	0.00877
132.743	......	....	....	1.180	112.896	114.076	18.667	3515.2	5.310	0.349	3.768	0.00897
129.144	......	....	....	1.117	112.896	114.013	15.131	3515.2	4.305	0.349	3.350	0.00905
123.794	......	....	....	1.011	112.896	113.907	9.887	3515.2	2.813	0.349	2.593	0.00933
120.847	.....	....	....	0.946	112.896	113.842	7.005	3515.2	1.993	0.349	2.143	0.00945
118.199	......	....	....	0.883	112.896	113.779	4.420	3515.2	1.257	0.349	1.648	0.00963
....	0.715	116.183	116.898	0.833	112.896	113.729	3.169	4054.9	0.782	0.349	1.212	0.01008
....	0.757	115.174	115.931	0.899	112.896	113.795	2.136	4054.9	0.527	0.349	0.951	0.01033
....	1.440	113.100	114.540	0.810	112.896	113.706	0.834	4054.9	0.206	0.349	0.522	0.01093
....	1.243	113.100	114.343	0.795	112.896	113.691	0.652	4054.9	0.161	0.349	0.453	0.01090

† By Cippoletti formula.

Table 7 gives the results of the experiments. Fig. 14 shows the variation of *n* with the velocity.

Some peculiar conditions were brought out during these experiments: When the pipe was first "tried out" in 1909, preliminary to making the experiments, it was impossible to get a larger quantity than 0.96 cu. ft. per sec. through it, even with a head of 5 ft. at the intake. It seemed certain that something must be wrong, as the probable flow under the conditions had been roughly estimated at between 1.5 and 2 cu. ft. per sec. Examination showed that air imprisoned in the pipe was causing the difficulty. This was overcome by inserting a ½-in. wrought-iron stand-pipe in the top of the pipe about 15 ft. below the intake. In this way the air was, to all appearances, entirely removed, and the carrying capacity was raised to 1.54 cu. ft. per sec.—an increase of about 60 per cent. In 1910 it was found that the pipe would carry 2.02 cu. ft. per sec. with practically the same loss of head—an increase of 31% over the maximum carried in 1909, and an increase of 110% over the quantity carried before the air was released.

The great increase in carrying capacity in 1910 over that found in 1909 is difficult to explain. The writer, at least, can offer no explanation, unless it be that there was still some air under pressure in the pipe during the 1909 experiments, after the stand-pipe was attached, and that this had the effect of increasing the losses to the extent indicated. This would appear to be the most plausible explanation, even after taking into account the fact that no additional air valves were inserted in 1910, the pipe having been operated under identical

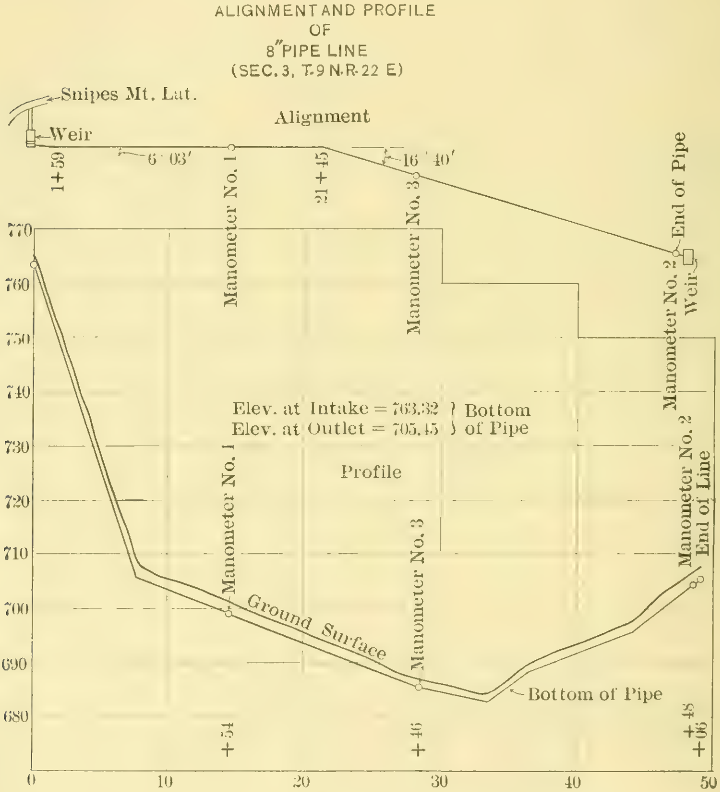


FIG. 11.

conditions. The pipe was used for about 6 months in the interval between the two sets of experiments, but it is hardly possible that it had worn so much smoother during this time, even if greater smoothness could have produced the effect indicated, which the writer does not believe to be the case. The presence of silt in the pipe cannot be offered as an explanation, as the velocities, ever since the pipe was put in operation, have been too high to permit the formation of any deposits. The writer also took other means of assuring himself that such a condition did not exist.

6-In. Jointed Wood Stave Pipe (1909).—This pipe was built in the spring of 1909, and had been in use about 5 months before the experiments were made. The pipe is only 1 000 ft. long, and the alignment consists of a single tangent. It runs under a very uniformly sloping ground surface, and only very light vertical curves are possible. No record of the profile of the pipe is available. The maximum length on which it was practicable to experiment was 500 ft. Water columns were used at both gauges, and the discharges were measured over a 12-in. Cippoletti weir for which the method of reduction has been described. The range of velocities was limited by conditions at the intake. Table 8 gives the results.

6-In. Jointed Wood Stave Pipe (1910).—This pipe has a total length of 4 000 ft., but, owing to the fact that there are several hydrants in the second half of its length, observations were made on only 1 801 ft. The pipe was built in the spring of 1910, and had been operated about 4 months before the experiments were made. The normal velocity during this time was about 3 ft. per sec.

The alignment and profile are very similar to those of the 8-in. pipe, and the manometers were favorably located as regards curvature, etc. There appeared to be a slight summit about 500 ft. above the second manometer. Water gauges were used at both stations, and the discharge was measured at the intake over a 12-in. Cippoletti weir. The results of the 1910 observations are also given by Table 8.

5-In. Jointed Wood Stave Pipe.—No positive information was obtained as to when this pipe was built, but it was probably about 2 years old at the time of the experiments. It has a total length of 3 000 ft., and observations were taken over a length of 1 822 ft. The diameter, as nearly as could be determined, is 5 in. The pipe seemed to be in good condition. It crosses a wide, shallow hollow, and runs

TABLE 8.—OBSERVED AND CALCULATED DATA ON 6-INCH JOINTED WOOD STAVE PIPE.

				WATER GAUGE NO. 1.			WATER GAUGE NO. 2.								
No.	Date.	Head on 1-ft. weir.	Discharge, c.f.s.	Aver. of readings.	Elev. of zero.	Elev. of water column.	Aver. of readings.	Elev. of zero.	Elev. of water column.	Loss of head.	Length of pipe.	Loss per 1 000 ft.	Area.	Velocity.	n
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
	1909														
1	Oct. 26	0.089*	0.0979†	1.448	92.475	93.923	1.438	92.360	93.798	0.125	500.4	0.250	0.196	0.499	0.01036
2	Oct. 26	0.1255*	0.1620†	0.761	92.475	93.236	0.571	92.360	92.931	0.305	500.4	0.610	0.196	0.827	0.01029
3	Oct. 26	0.151*	0.2127†	0.672	92.475	93.147	0.289	92.360	92.649	0.498	500.4	0.995	0.196	1.085	0.01020
4	Oct. 26	0.178*	0.2700†	1.386	92.475	93.861	0.714	92.360	93.074	0.787	500.4	1.573	0.196	1.378	0.01018
5	Oct. 26	0.2055*	0.3340†	1.323	92.475	93.798	0.302	92.360	92.662	1.136	500.4	2.270	0.196	1.704	0.01008
	1910														
1	Sept. 15	0.1305	0.159‡	0.428	102.773	103.201	0.999	101.111	102.110	1.091	1801	0.606	0.196	0.811	0.01041
2	Sept. 15	0.149	0.194‡	1.056	102.773	103.829	1.043	101.111	102.154	1.675	1801	0.930	0.196	0.990	0.01063
3	Sept. 15	0.1085	0.121‡	0.999	101.734	102.733	0.956	101.111	102.067	0.666	1801	0.370	0.196	0.617	0.01045
4	Sept. 15	0.093	0.096‡	0.737	101.734	102.471	0.925	101.111	102.036	0.435	1801	0.240	0.196	0.490	0.01032
5	Sept. 16	0.082	0.079‡	0.569	101.734	102.303	0.903	101.111	102.014	0.289	1801	0.160	0.196	0.403	0.01002
6	Sept. 16	0.177	0.251‡	0.876	104.980	105.856	0.192	103.159	103.351	2.505	1801	1.391	0.196	1.281	0.01026
7	Sept. 16	0.199	0.299‡	0.628	107.493	108.121	1.229	103.159	104.388	3.733	1892	1.973	0.196	1.526	0.01029
8	Sept. 17	0.3125	0.588‡	1.216	119.334	120.550	1.416	105.211	106.627	13.923	2021	6.889	0.196	3.000	0.00998
9	Sept. 17	0.264	0.456‡	0.650	112.751	113.401	0.064	105.211	105.275	8.126	1892	4.295	0.196	2.327	0.01069

* These heads were measured over a weir having a galvanized-iron crest.

† These discharges were derived from a comparison between a weir having a galvanized-iron crest and one having a sharp crest.

‡ By Cippoletti formula.

under low pressure. No records are available as to its profile, except a few sights taken on the surface of the ground and a general observation of the surface, which would indicate a gradual fall and rise of the pipe grade. The alignment consists of a single tangent. The results are shown in Table 9.

The discharge was measured at the outlet over an 8-in. sharp-crested Cippoletti weir. Water columns were used for measuring all pressures at the outlet, Manometer No. 2, and for all but two observations at Manometer No. 1. A mercury column was necessary for Observations 3 and 4 on account of the increased pressures. The pipe carried considerable air in the first 1 000 ft., and it seemed to be practically impossible to get rid of it. For this purpose, four ½-in. taps were inserted in the top of the pipe in the first 600 ft., but without success. The manometers were placed outside of this zone, and air disturbances caused no particular trouble in taking the readings.

4-In. Jointed Wood Stave Pipe.—This pipe was built in 1907, and had been in service 3 years. The velocity of the water during this time was about 3.5 ft. per sec. It runs under a low head, on a continuous down grade to an outlet in a stand-pipe about 6 ft. high. The total length is 1 200 ft. The alignment consists of a single tangent. Table 10 gives the results of the observations, and Fig. 15 shows the variations of n with the velocity.

The discharge was measured over a 12-in. sharp-crested Cippoletti weir. It was found impossible to maintain an absolutely regular flow through the pipe, and the gauges, therefore, were somewhat unsteady. The averages obtained, however, are considered to represent the actual conditions within any practical limit of accuracy. Water columns were used for all gauges. For the two largest quantities, observations were taken on a length of 1 109.5 ft., but, for the smaller pressures, only 603 ft. could be utilized. The average diameter, as measured, was 4 in. The smaller discharges may be open to suspicion, on account of the low heads over the weir. The writer wishes that this condition had not obtained, but he is not ready to agree that any error from this source could be appreciable. This same objection might also be urged against the lower discharges on some of the other pipes.

At the intake, which point offered the only opportunity for an examination, it was noted that the interior surface was covered with a fungous growth, from ⅛ to $\frac{3}{16}$ in. in thickness. It is not known

TABLE 9.—OBSERVED AND CALCULATED DATA ON 5-INCH JOINTED WOOD STAVE PIPE.

No.	Date, 1909.	Head on 8-in. weir.	Discharge by Cippoletti formula, c. f. s.	GAUGE NO. 1.								GAUGE NO. 2.		LOSS OF HEAD.		Area.	Velocity.	*n*.
				Mercury gauge. C = 1.091 ft. Elev. of "L" zero, 99.687.					Water gauge.			Water gauge. Elev. of zero, 100.964.						
				U.	L.	Mercury.	Water equivalent.	Elev. of water col.	Aver. of readings.	Elev. of zero.	Elev. of water col.	Aver. of readings.	Elev. of water col.	Length, 1 822 ft.	Per 1 000 ft.			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
1	Oct. 13	0.1540	0.136	......	......	......	....	....	0.372	103.621	103.993	0.639	101.603	2.390	1.312	0.136	1.000	0.01082
2	Oct. 13	0.1855	0.179	......	......	......	....	....	1.207	104.435	105.642	0.734	101.698	3.944	2.165	0.136	1.316	0.01069
3	Oct. 13	0.2690	0.313	0.152	0.246	0.997	13.785	113.472	....	....	....	1.044	102.008	11.464	6.292	0.136	2.301	0.01055
4	Oct. 15	0.2680	0.311	0.125	0.246	0.970	13.419	113.106	....	....	....	1.030	101.994	11.112	6.099	0.136	2.287	0.01048
5	Oct. 15	0.0860	0.057	......	......	......	....	....	1.034	100.877	101.911	0.504	101.468	0.443	0.243	0.136	0.419	0.01041
6	Oct. 15	0.1165	0.089	......	......	......	....	....	0.671	101.885	102.556	0.563	101.527	1.029	0.565	0.136	0.654	0.01066
7	Oct. 15	0.1345	0.111	......	......	......	....	....	1.206	101.885	103.091	0.602	101.566	1.525	0.837	0.136	0.816	0.01057
8	Oct. 15	0.1990	0.199	......	......	......	....	....	0.878	105.413	106.291	0.807	101.771	4.520	2.481	0.136	1.463	0.01042

TABLE 10.—OBSERVED AND CALCULATED DATA ON 4-INCH JOINTED WOOD STAVE PIPE.

No.	Date, 1910.	Head on 1-ft. weir.	Discharge by Cippoletti formula, c. f. s.	Leakage above Gauge No. 1, c. f. s.	Net disch., c. f. s.	WATER GAUGE NO. 1.			WATER GAUGE NO. 2.			Loss of head.	Length of pipe.	Loss per 1 000 ft.	Area.	Velocity.	*n*
						Average of readings.	Elevation of zero.	Elevation of water column.	Average of readings.	Elevation of zero.	Elevation of water column.						
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
1	Oct. 18	0.2370	0.388	....	0.388	0.866	132.811	133.677	0.171	105.359	105.530	28.147	1 109.5	25.369	0.087	4.460	0.00956
2	Oct. 18	0.2050	0.312	....	0.312	1.204	131.782	132.986	0.995	112.601	113.596	19.390	1 109.5	17.476	0.087	3.586	0.00977
3	Oct. 19	0.1230	0.156	0.010	0.146	0.925	106.839	107.764	0.452	104.354	104.806	2.958	603.0	4.905	0.087	1.678	0.01065
4	Oct. 19	0.1120	0.126	....	0.126	1.363	106.839	108.202	0.593	105.385	105.978	2.224	603.0	3.688	0.087	1.448	0.01068
5	Oct. 20	0.0590	0.049	0.012	0.037	1.808	106.839	108.647	0.990	107.377	108.367	0.280	603.0	0.464	0.087	0.425	0.01178
6	Oct. 20	0.0930	0.096	0.005	0.091	0.758	106.839	107.597	0.885	105.380	106.265	1.332	603.0	2.209	0.087	1.046	0.01116
7	Oct. 20	0.0735	0.067	....	0.067	1.074	106.839	107.913	0.757	106.397	107.154	0.759	603.0	1.259	0.087	0.770	0.01129

whether this condition exists throughout the length of the pipe, but, if it does, the area of the cross-section must be materially affected thereby, which would make the results quite different from those given in Table 10. The writer has had no opportunity to observe any growth of this nature, and is not prepared to offer an opinion as to the probability of its presence throughout the pipe. He would be glad to have some light on this subject.

Discussion of Results.

The diagram, Plate CXLV, contains a comprehensive plotting of the entire set of experiments. The scales are logarithmic, and were chosen because they afford the easiest means of examining the results, and because engineers have become accustomed to this method of analyzing experimental data. That the method is especially adapted to an analysis of experimental data on the flow of water in pipes requires no demonstration.

Before proceeding to an explanation of the diagram it should be stated that the writer has assumed that the loss of head in any wood stave pipe can be represented by an equation of the general form:

$$H = K\ D^z\ V^x;$$

where K, z, and x are constants to be determined by experiment;

H = the loss of head, in feet per 1 000 ft.;
D = the diameter of the pipe, in inches;
and V = the mean velocity of flow, in feet per second.

By assuming that $K\ D^z = m$, the formula can be broken into two equations, as follows:

$$m = K\ D^z \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

$$\text{and } H = m\ V^x \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Both of these, being exponential equations, will plot as straight lines on logarithmic scales. The experimental data give the corresponding values of H and V, and, after plotting these for each pipe, the values of m and x can be readily determined, thus making the required constants known. In Plate CXLV the curves with positive slope represent this plotting. The appropriate scales are above and on the left of the diagram, representing "Loss of head per 1 000 ft." and "Velocity, in feet per second," respectively. The value of x is represented by the slope of the curve, and, as the horizontal and vertical scales of the diagram have the same spacing, this value is given

PLATE CXLV.
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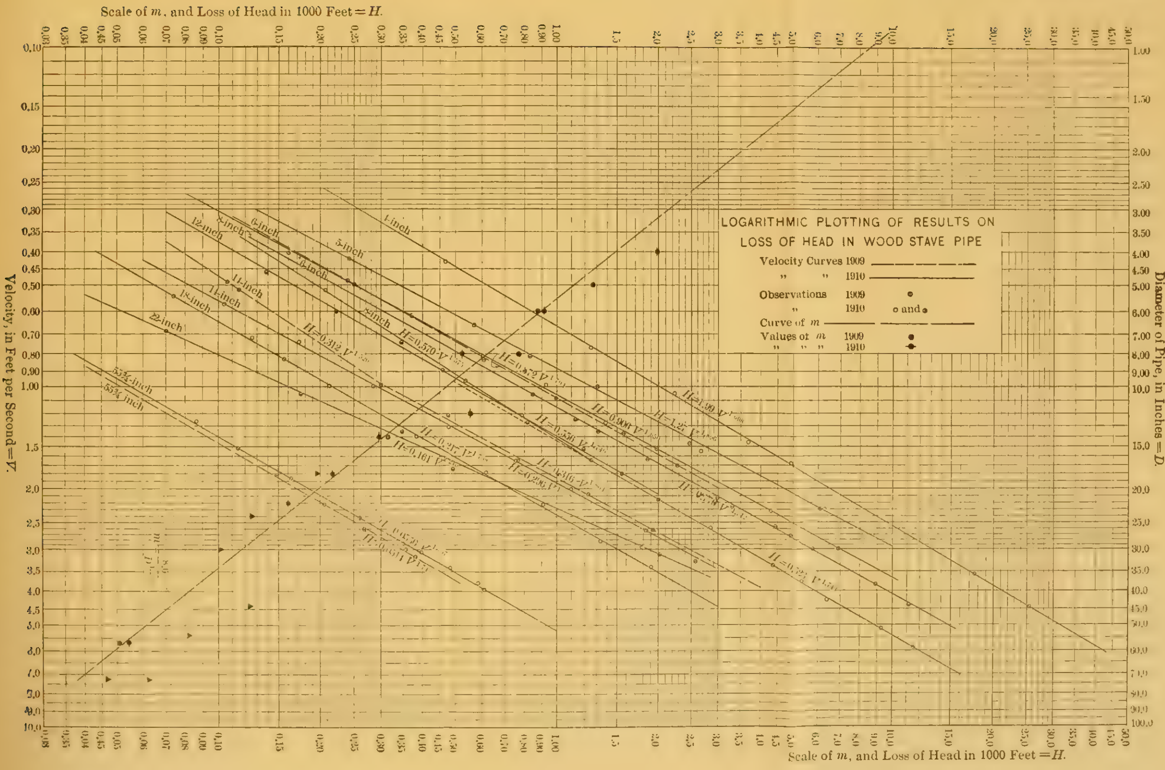
MORITZ ON
FLOW OF WATER IN WOOD PIPE.



directly by the tangent of the angle between the curve and the vertical axis. The value of m is represented by the intercept of the curve on the line for $V = 1$. The values thus obtained have been substituted in the general equation, $H = m\ V^x$, and the appropriate equation is written over each curve in the diagram.

In the equation, $m = K\ D^z$, we now have corresponding values of m and D, so that, by plotting these values, it is possible to determine K and z. The appropriate scales for this plotting are above and on the right of the diagram. It happens that the scale for values of m can also be used for values of H. It also happens that the scale of pipe diameters at the right is ten times the scale of velocities at the left, thus simplifying the diagram considerably. The points representing the relation between the values of m and x, found as above described, are the circular solid black ones. The dashed line with negative slope is intended to represent the average of these. The slope of this line is the value of z, and its intercept on the line for $D = 1$ is the value of K. The equation of this line is thus found to be $m = 8.6\ D^{-1.263}$.

Attention is called to the fact that for the 8-in. pipe (1910 series) and for the 14-in. pipe (1909 series) two slopes are given, a dashed line being required to represent properly the locus of all the points. The writer has been unable to find an explanation for this phenomenon. It may be an indication of "critical velocity" conditions, but the data necessary to establish this point are too meager to warrant an analysis. The strange part of it is that this phenomenon did not develop on any of the other pipes. In determining the values of m, the higher slopes only have been used.

For the purpose of argument, the writer wishes to state that he has concluded that the following values of the constants best represent the average results of these experiments:

$$x = 1.8$$
$$z = -1.263$$
$$m = 8.6$$

Disregarding the lower slopes for the 8 and 14-in. pipes, it will be noted that the values of x vary from a minimum of 1.698 for the 4-in. pipe to a maximum of 2.215 for the 22-in. pipe. It will also be noted that the remaining values lie between 1.746 and 1.896, while most of them are between 1.746 and 1.85—not a large range, but sufficiently large to give quite wide variations in calculated quantities.

The average value, excluding the value of 2.215 for the 22-in. pipe, is 1.795. The writer would exclude this value, as being abnormal and far from representing average conditions. He also is quite firmly convinced that a thorough, scientific investigation of this same pipe would reveal the cause of the difficulty, and that it could be remedied without great trouble or expense.

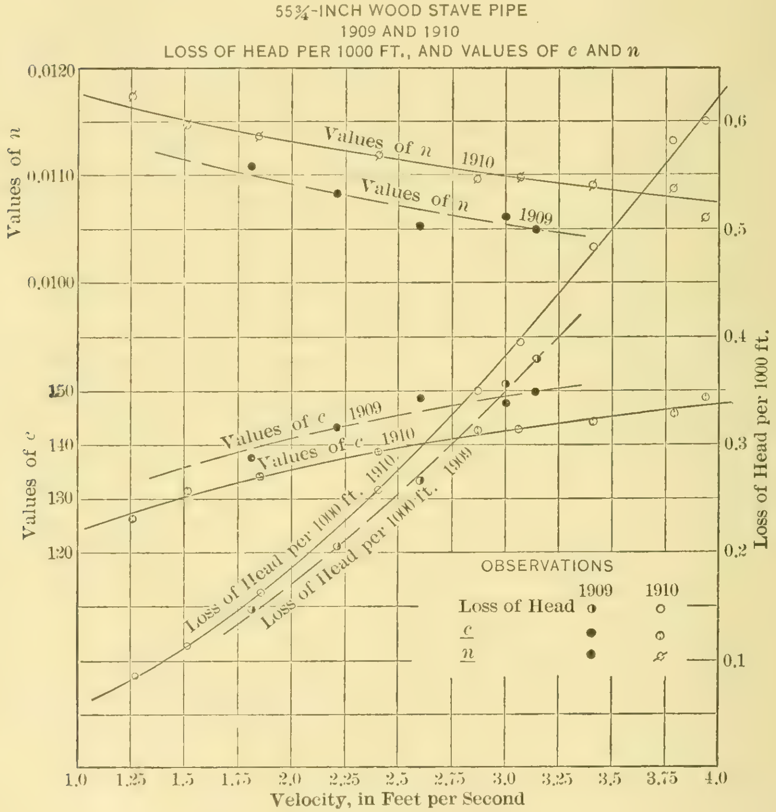


Fig. 12.

Pursuing this subject further, it might be inferred from previous statements that the 8-in. pipe of 1909 and the 12-in. pipe were operated under abnormal conditions, and that the values of x for these pipes should not be used in deducing the average. Leaving out these values, the average would be 1.798, as compared with 1.795—a difference not worthy of discussion—but this does not answer the question, and the writer can offer no strenuous argument for not leaving the 8-in. pipe out of consideration. If left out, the effect on the average value of x is slight, and there does not seem to be sufficient reason for doing so. During the 1909 experiments the writer was under the impression that the pipe was operating under normal conditions, but some generous spirit evidently entered the field in the interim, and the 1910 experiments showed quite different results. Most of the difference, however, is shown in the position of the curve rather than in its slope. In regard to the 12-in. pipe, the writer contends that the slope is normal, and that the nature of the abnormality, namely, the presence of silt in the pipe, is such as to affect, principally, the position of the curve and not its slope. This argument, of course, is not founded on an analysis of this pipe alone, but on a comparison with the entire series, which the writer considers is the only proper and safe method of deducing logical

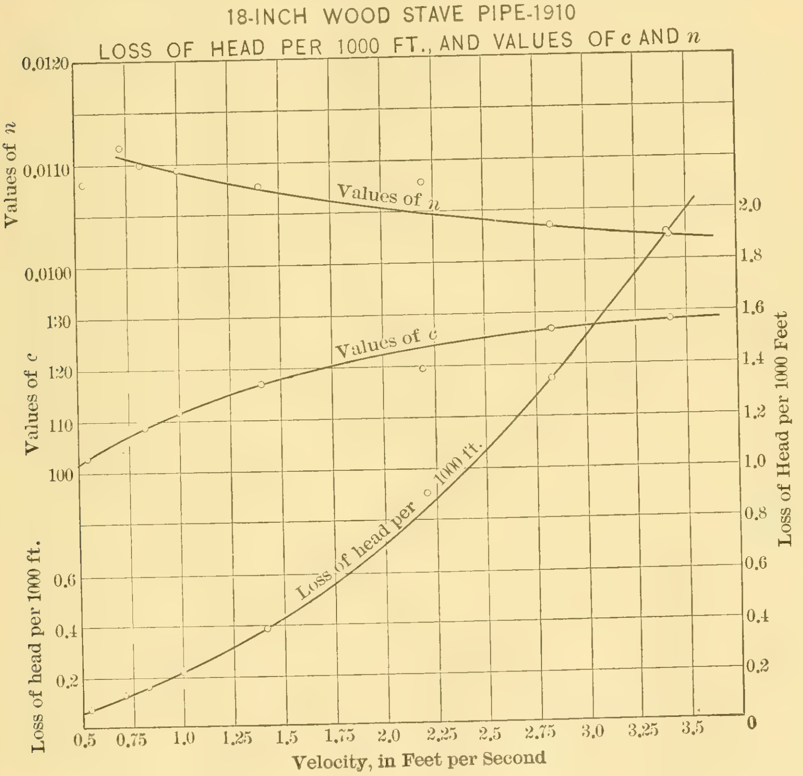


FIG. 13.

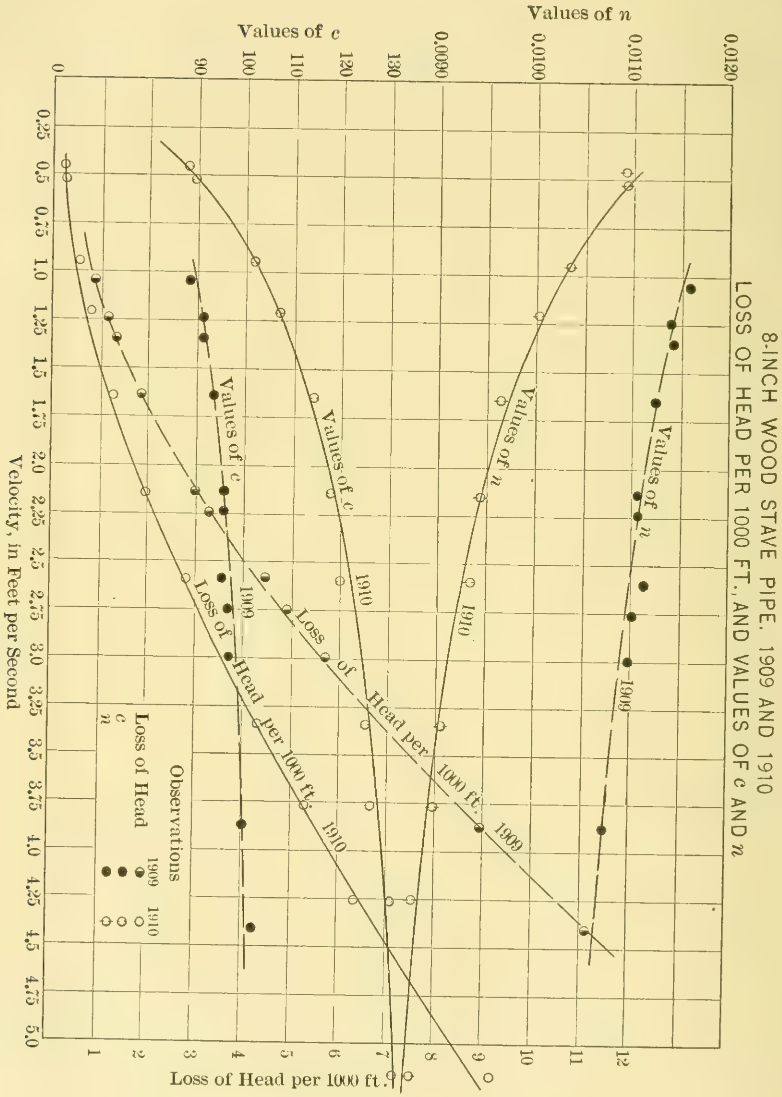

8-INCH WOOD STAVE PIPE. 1909 AND 1910
LOSS OF HEAD PER 1000 FT., AND VALUES OF c AND n
Values of n
0.0090
0.0100
0.0110
0.0120
Values of c
0
90
100
110
120
130
Values of n
1909
Values of n
1910
Values of c
1910
Values of c
1909
Loss of Head per 1000 ft.
1909
Loss of Head per 1000 ft.
1910
Observations
1909 1910
Loss of Head
c
n
0.25
0.5
0.75
1.0
1.25
1.5
1.75
2.0
2.25
2.5
2.75
3.0
3.25
3.5
3.75
4.0
4.25
4.5
4.75
5.0
Velocity, in Feet per Second
1
2
3
4
5
6
7
8
9
10
11
12
Loss of Head per 1000 ft.

FIG. 14.

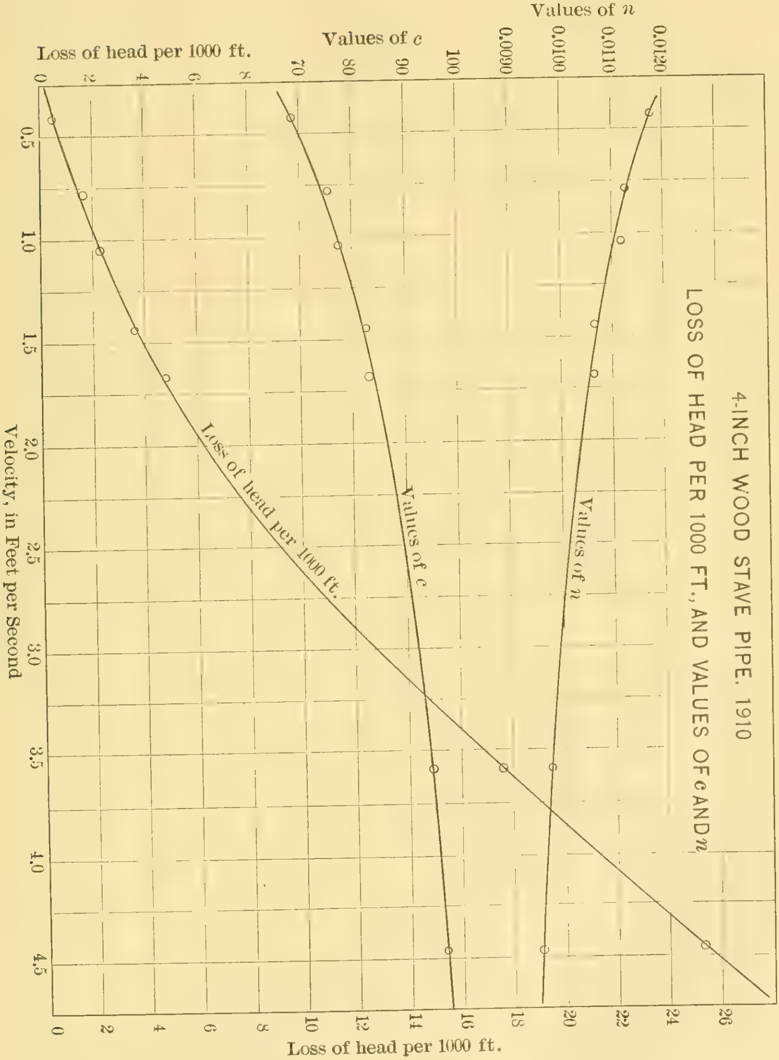

4-INCH WOOD STAVE PIPE. 1910
LOSS OF HEAD PER 1000 FT., AND VALUES OF c AND n
Values of n
0.0090
0.0100
0.0110
0.0120
Values of c
70
80
90
100
Loss of head per 1000 ft.
0
2
4
6
8
10
12
14
16
18
20
22
24
26
Velocity, in Feet per Second
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
Loss of head per 1000 ft.
Values of c
Values of n

Fig. 15.

conclusions in regard to any single pipe. This same argument would apply to the 4-in. pipe, also, in case the flow conditions here should be considered abnormal on account of the possible presence of fungous growth on the inner surface.

Proceeding now to the determination of the values of z and K: As already stated, the general equation of the dashed line of negative slope shown in the diagram is $m = K\ D^z$, the values of m being given on the scale on the top, and values of D being given at the right. In drawing this line the principal weight has been attached to the 5, 6, 8, 14, 18, and 55¾-in. pipes. It happens that the point for the 22-in. pipe falls quite close to the average line, although no weight was given to it in determining this line. The reason for disregarding this point is that the slope is so widely at variance with the general average that it was not thought fair to give much more weight to the intercept point than was attached to the slope in the determination of the average value of x. The logic of this, however, cannot be demonstrated by the writer. It is a matter of opinion only. There is good reason for disregarding the point for the 12-in. pipe, as there is no doubt that the position of the 12-in. line is abnormal, and, as already stated, the presence of silt could account for the entire discrepancy in position, and, very probably, without altering the slope of the line. A similar argument can be applied to the 4-in. pipe, though not so conclusively. These arguments are based on hypotheses, not on known facts, and the writer is not prepared, at present, to defend them with facts. He believes, however, that the deductions are justified by the experiments until such time as evidence to the contrary is available.

Assuming now that the line as drawn represents the true average, its slope is calculated and gives $z = -1.263$; then, reading the intercept on the $D = 1$ line, $K = 8.6$.

All the constants in the general equation, $H = K\ D^z\ V^x$, have now been determined, and we may write

$$H = 8.6\ D^{-1.263}\ V^{1.8}$$

as the formula for loss of head in wood stave pipe, as determined by these experiments,

in which H = the loss of head, in feet per 1 000 ft.;
D = the diameter of the pipe, in inches;
and V = the mean velocity of flow, in feet per second.

The writer has adopted for his use the formula:

$$H = 8.6\ D^{-1.26}\ V^{1.8}$$

or, reducing this to a more practical form, and expressing the diameter in feet instead of inches:

$$Q = 1.353\ D^{2.70}\ H^{0.555}.$$

This formula is not recommended for adoption until more data are available and some of the uncertain points have been cleared up, but, until this is accomplished, the writer feels fairly safe in using it. With good conditions, and scientific and careful operation and maintenance, it should give results within 10% of the true quantities for velocities from 0.5 to 6 ft. per sec.

Values of Kutter's *n* as Applied to Wood Stave Pipes.

It has become generally recognized that Kutter's coefficients have no direct application to the flow of water in pipes, but, as additional proof of the fallacy of these coefficients, four good examples have been selected from the pipes covered by these experiments, and curves have been drawn representing the values of n and c (Chezy formula) and corresponding values of velocity. Incidentally, the diagrams also show the curves representing the relation of loss of head to velocity. For the 8 and 55¾-in. pipes two sets of such curves are shown, representing the results of the 1909 and 1910 experiments.

The curves selected show a comparatively uniform variation. The remaining experiments show a very non-uniform variation, and no simple curve can even approximate the locus of all the points. The values of n for the 22-in. pipe show a variation directly the opposite of that represented in the curves given, that is, the value of n increases with the velocity. However, in the light of the results for this pipe already given, this is not so surprising.

The writer has also prepared Table 11, showing the value of n, for each of the pipes tested, for velocities of 0.5, 1.0, 2.0, 3.0, and 4.0 ft. per sec. On account of the difficulty of obtaining an average line to represent all the points, many of the values are necessarily very rough. By comparing these values with diameters horizontally and with velocities vertically, it is evident at a glance that no uniform relations exist.

The writer knows of engineers who, in the absence of better data, have used a scale of values of n depending on the pipe diameter; using smaller values for the smaller pipes. How this idea originated the writer does not know, but he does not believe that it is supported by any known facts. It is certainly not in harmony with the present experiments. There is just as much, and probably more, foundation in fact for making n vary with the velocity as with the diameter.

TABLE 11.—VALUES OF KUTTER'S n FOR VARIOUS DIAMETERS AND VELOCITIES.

Velocity.	DIAMETERS, IN INCHES.												
	4	5	6 1909	6 1910	8 1909	8 1910	12	14 1909	14 1910	18	22	55¾ 1909	55¾ 1910
0.5	0.0117	0.0105	0.0103	0.0103	......	0.0110	0.0130	0.0118	0.0104	0.0112	0.0096	......	......
1.0	0.0111	0.0107	0.0102	0.0105	0.0115	0.0103	0.0128	0.0114	0.0108	0.0109	0.0107	......	0.0118
2.0	0.0104	0.0106	0.0100	0.0102	0.0111	0.0095	0.0122	0.0109	0.0108	0.0105	0.0120	0.0109	0.0113
3.0	0.0099	......	......	0.0100	0.0109	0.0091	......	0.0105	0.0106	0.0103	0.0126	0.0105	0.0110
4.0	0.0096	......	......	......	0.0107	0.0089	......	......	......	......	......	......	0.0108

COMPARISON WITH OTHER EXPERIMENTS.

A satisfactory comparison of these with other experiments previously published, notably those of Mr. T. A. Noble on 44 and 54-in. pipes, and Messrs. Marx, Wing, and Hoskins on a 72-in. pipe, is a difficult and discouraging problem. The writer had intended to make such a comparison and include it in this paper, but this would have taken more time than was available. Furthermore, the results of previous experiments are so at variance with those described in this paper that it is doubtful whether any satisfactory balance of all available data can be made. It is hoped, however, that some scientifically minded person will make a serious attempt to do this, and there is no doubt that he will receive the thanks of the Engineering Profession if he succeeds.

It is interesting to note the position of the points representing the values of m for the other tests with respect to the writer's average line. These points are indicated by solid black triangles. The only one that falls near the line is that for the 14-in. pipe tested by Adams, which falls almost exactly on it. For the 18-in. pipe by Adams, the 24-in. pipe by Gutillius, and the 30-in. pipe by Schuyler, only one test each was available, and the intercepts were determined by running through these points a line having a slope of 1.8. This is, of course, a makeshift, and the resultant m points do not represent true experimental data. It happens that the observations on the 24-in. pipe were made at a velocity of about 1 ft. per sec., so that the m point could not be far off, whatever the slope of the line run through it. For the 44, 54, and 72-in. pipes, complete data are available, and the points shown are based on these.

It has been the intention, through this paper and in the various tables and diagrams, to present complete data, so that all reductions could be worked over in any form, and if this aim has not been realized, additional notes or information can be furnished to any one desiring them. The original field notes are on file in the office of the Reclamation Service, at Sunnyside, Wash.

The writer hopes that this paper contains valuable information, and that it will receive a thorough discussion, so that all doubtful and disputed points on this subject may be cleared up, as far as possible.

Vol. XXXVII. OCTOBER, 1911. No. 8.

AMERICAN SOCIETY OF CIVIL ENGINEERS

INSTITUTED 1852

PAPERS AND DISCUSSIONS

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THE ST. CROIX RIVER BRIDGE.

By C. A. P. Turner, M. Am. Soc. C. E.

To be Presented December 6th, 1911.

The Wisconsin Central Railroad, now leased by the Soo Line, and forming the Chicago Division of that road, is being rapidly improved in order to offer to the traveling public service second to none between the Twin Cities and Chicago. The shortening of the line and the reduction of the grades by a number of changes in location are almost completed.

One of the most marked improvements is in that portion of the line near the St. Croix River, 7 miles above Stillwater, Minn. This new cut-off crosses the river at an elevation of 180 ft. above mean water level, and presents some novel and interesting engineering features. The bridge structure is 2 600 ft. in length. The river bed at this point is 1 800 ft. wide, between high sandstone bluffs, but the full width is overflowed only at high water. The material forming the bottom seems to be fairly uniform throughout, consisting of fine sand and silt, easily eroded, and extending down from 100 to 120 ft. to bed-rock.

The piers of the old bridge, $\frac{3}{4}$ mile below the new, are of masonry

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Note.—These papers are issued before the date set for presentation and discussion. Correspondence is invited from those who cannot be present at the meeting, and may be sent by mail to the Secretary. Discussion, either oral or written, will be published in a subsequent number of *Proceedings*, and, when finally closed, the papers, with discussion in full, will be published in *Transactions*.

In the *Proceedings* of this Society, the Papers and the Discussions on Papers will hereafter be printed so that each will commence on an odd-numbered page. This is done by special request, in order to enable members who wish to do so to separate the Papers and Discussions for filing under various engineering subjects.

resting on wooden piles, cut off and capped with timber in the old-fashioned style. They seem to have been gradually shifting down stream, and to have moved from 6 to 8 in. from their original position at the top, as determined by observations from year to year.

One of the holes drilled to bed-rock, in the line of the new bridge, developed a flowing well, delivering, by Artesian pressure, a 2-in. stream of clear spring water 12 ft. above the river level.

With such conditions to meet, the problem of economic and satisfactory foundations required as careful consideration as that of the superstructure.

Selection of Type and Design.—When foundations are inexpensive, no type of structure has been evolved which is less in cost than the tower and girder trestle, and a design using 100-ft. girders between bents and 40-ft. girders over towers was examined, and this, in turn, was compared with trestle approaches and five 350-ft. arch spans, both in reinforced concrete and in structural steel.

The reinforced concrete design required more expensive foundations and, for a single-track bridge, offered insufficient economy in the superstructure to offset such expense.

The superstructure of the trestle design could be built for nearly $60 000 less than the arch design. Rip-rap for piers, on the other hand, would cost $10 000 more for the trestle, due to the increased number of piers; piles would have cost $25 000 more, and concrete $60 000, leaving a net saving for the longer spans of approximately $35 000.

A design intermediate in cost was submitted by the McClintic-Marshall Construction Company, using 200-ft. lattice girders between towers.

A further advantage possessed by the structure of longer span is the longer and wider piers and the decreased probability that they might be weakened by erosion. The box-girder top chords give a width of floor of 12 ft. from out to out, and 6 ft. 2 in. between flanges, which is more satisfactory than the floor of the ordinary girder bridge.

Foundations.—The trestle foundations and end abutments rest on sand rock. The four intermediate piers rest on piles, as at their location it is from 100 to 125 ft. to bed-rock.

The piles are of Norway pine, from 70 to 85 ft. in length. The penetration ranged from 50 to 80 ft. No grillage was used, the piles projecting about 4 ft. into the concrete mass of the pier. There are

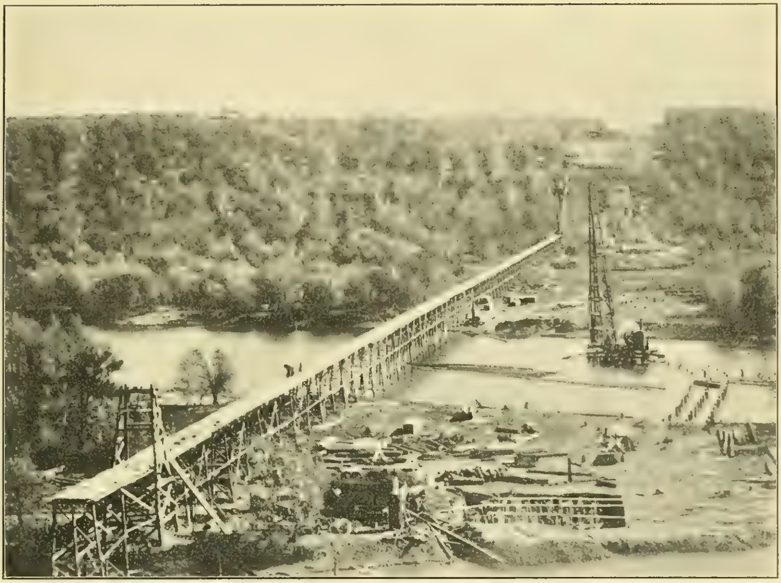


FIG. 1.—PILE-DRIVER, AND TRESTLE FOR HANDLING CONCRETE.

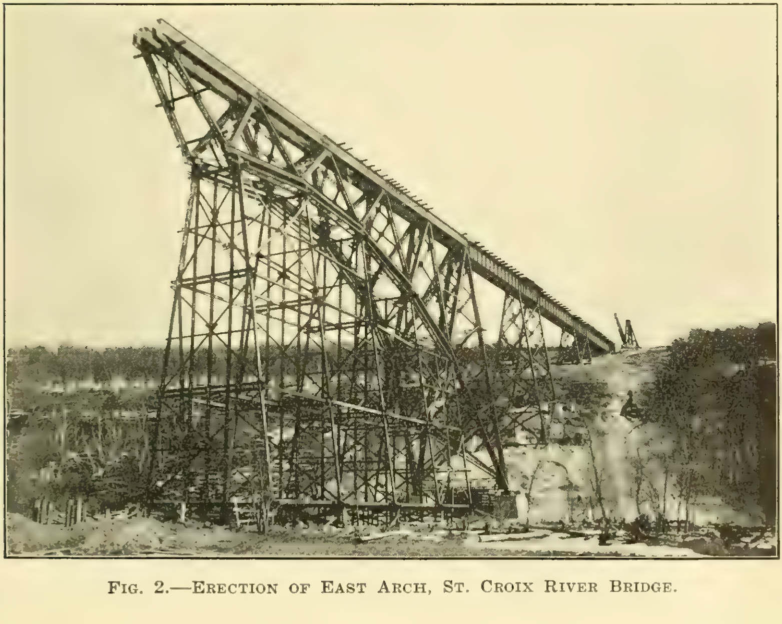


FIG. 2.—ERECTION OF EAST ARCH, ST. CROIX RIVER BRIDGE.

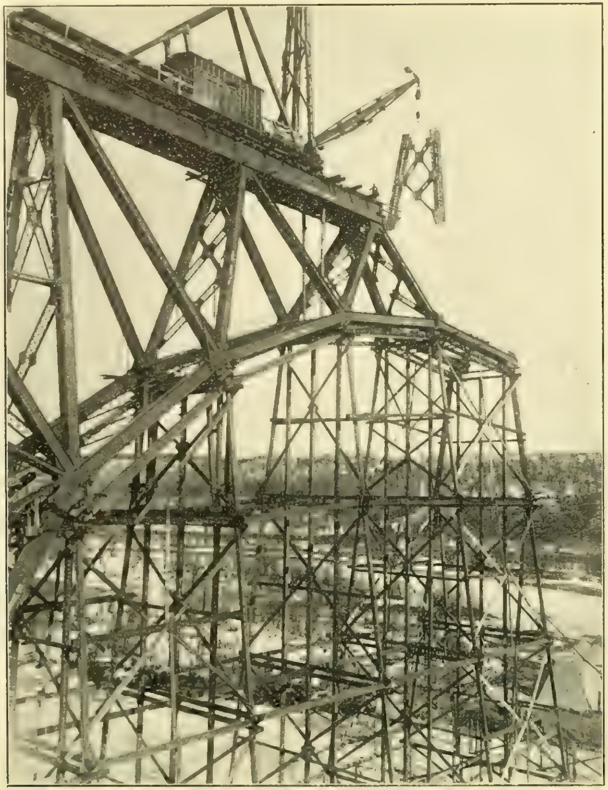


FIG. 1.—ERECTION OF WEST ARCH, ST. CROIX RIVER BRIDGE.

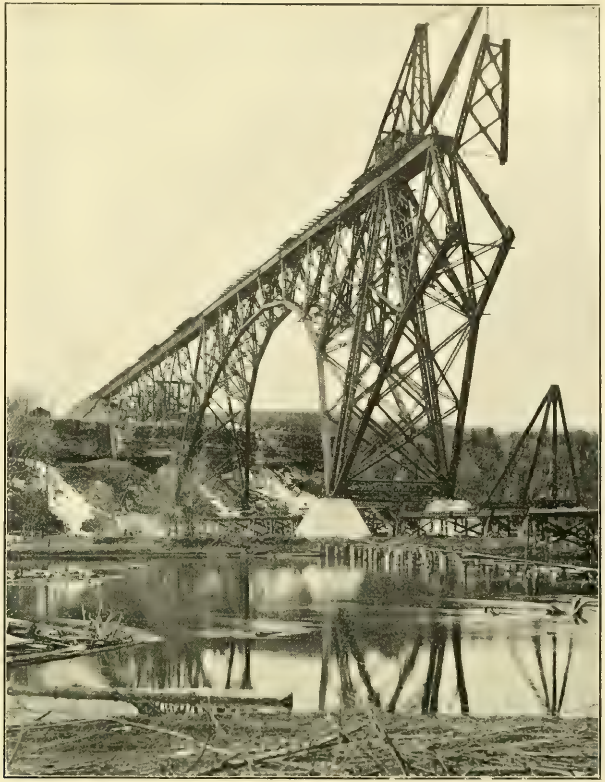


FIG. 2.—ERECTION OF HALF OF SECOND ARCH AS A CANTILEVER.

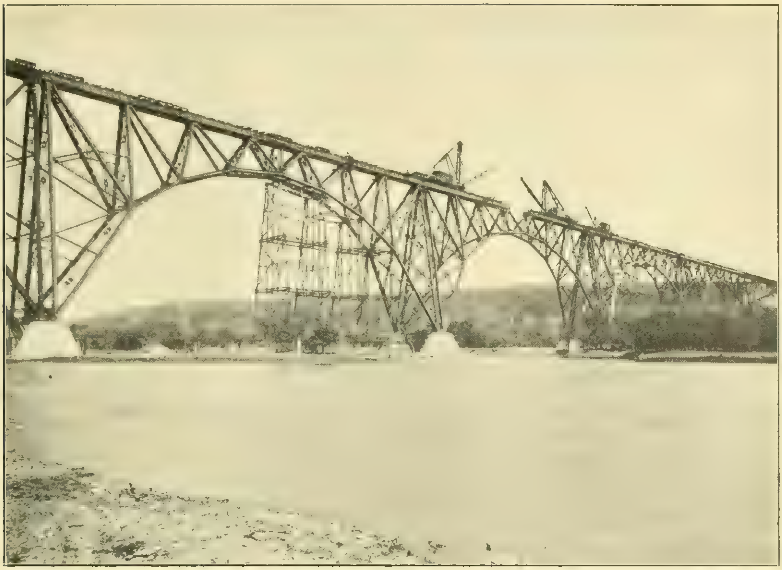


FIG. 1.—ERECTION OF CENTER ARCH WITHOUT FALSEWORK, AND THE HALF FALSEWORK USED FOR TWO ADJACENT SPANS.

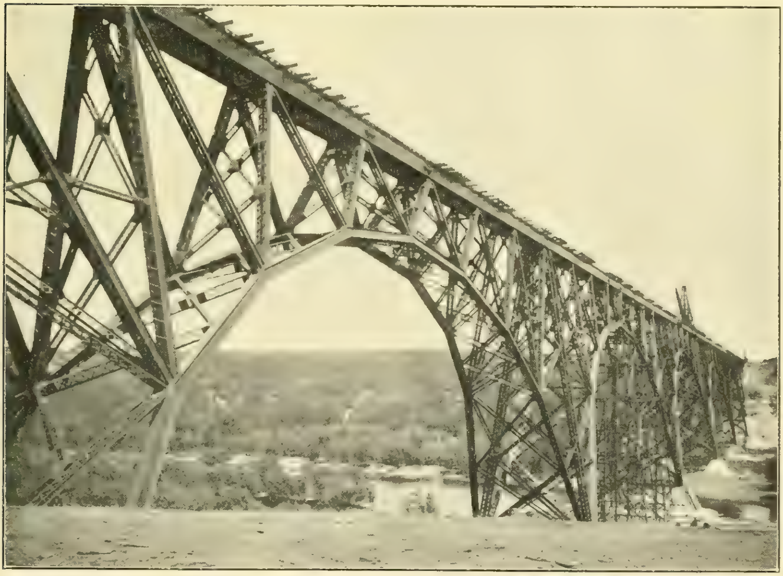


FIG. 2.—THE CLOSURE OF THE CENTER SPAN.

110 piles in each pier. Most of them were driven by a steam hammer, and the time of driving ranged from 25 to 40 min. per pile. The penetration at the start was about 2 in. per blow, and, under the last blows of the hammer, it ranged from nothing to ¼ in.

The concrete for the piers was mixed on top of the bluff, on both the east and west sides, and was distributed as follows: A light timber trestle was constructed about 6 ft. higher than the top of the piers, and to one side. At the east end, the concrete was carried by a chute to a hopper and elevated sufficiently above the floor of the trestle to spout into a ½-yd. car. At the west end, a cableway carried the concrete from the mixer over the main channel to the end of the trestle, a distance of approximately 400 ft.

Fig. 1, Plate CXLVI, is a view of the trestle, cableway, and pile-driver.

Type of Span.—The type of span adopted was the three-hinged arch, with trusses battered 2 in. in 12. This inclination of the trusses renders them remarkably rigid in a lateral direction, and involves some skew details in the connections. Then, by a simple expedient, these were all reduced to simple bends.

For example, in the lateral connection for the bottom chord in the first panel beyond the shoe, the plate is bent centrally, about an axis transverse to the truss, to the same angle as that made by the intersection of the main chords projected on a vertical plane, while longitudinally there are two different bevel angles to meet the flange of the chords of different inclination. Slotting the plate, on the line of the transverse bend, to its intersection with the lines of longitudinal bend, leaves them simple bends, in place of die forgings.

The advantage of the three-hinged over the two-hinged or restrained type may be summarized as follows:

First.—The stresses are statically determinate, and provision is made for temperature stresses.

Second.—The frame adjusts itself to any inaccuracy of the foundation work, or slight settlement, without material change in the stress of the various members.

On the other hand, the ordinary three-hinged arch is inferior to the two-hinged in point of stiffness, and has generally been considered unsuitable for railroad traffic. The depth of many three-hinged arches has been made so attenuated on approaching the crown that the complaint concerning this type in that form is well founded.

In the design of the St. Croix River Bridge, the depth of the crown is 25 ft. and the rise is 124 ft., so that the truss has ample depth throughout.

In order to combine the advantages of two-hinged and three-hinged arches, as far as practicable, the connection of the central top chord was made in the form of a friction joint of five plates, two of bronze and three of steel, giving six friction surfaces. As soon as the live load comes on the central chord, these joints lock by friction as firmly as though riveted, and the frame then deports itself as a two-hinged arch.

This feature of the design, together with the inclination of the truss, renders the structure one of the most rigid in existence.

Erection.—The bridge was erected from both ends toward the center. The equipment consisted of four derrick cars, a lighter one at each end being used for unloading and sorting the material and bringing it to the end of the bridge, where it was handled by the heavier cars.

The end arches, throughout, were erected on falsework, which was placed by the derrick cars as the work was built out.

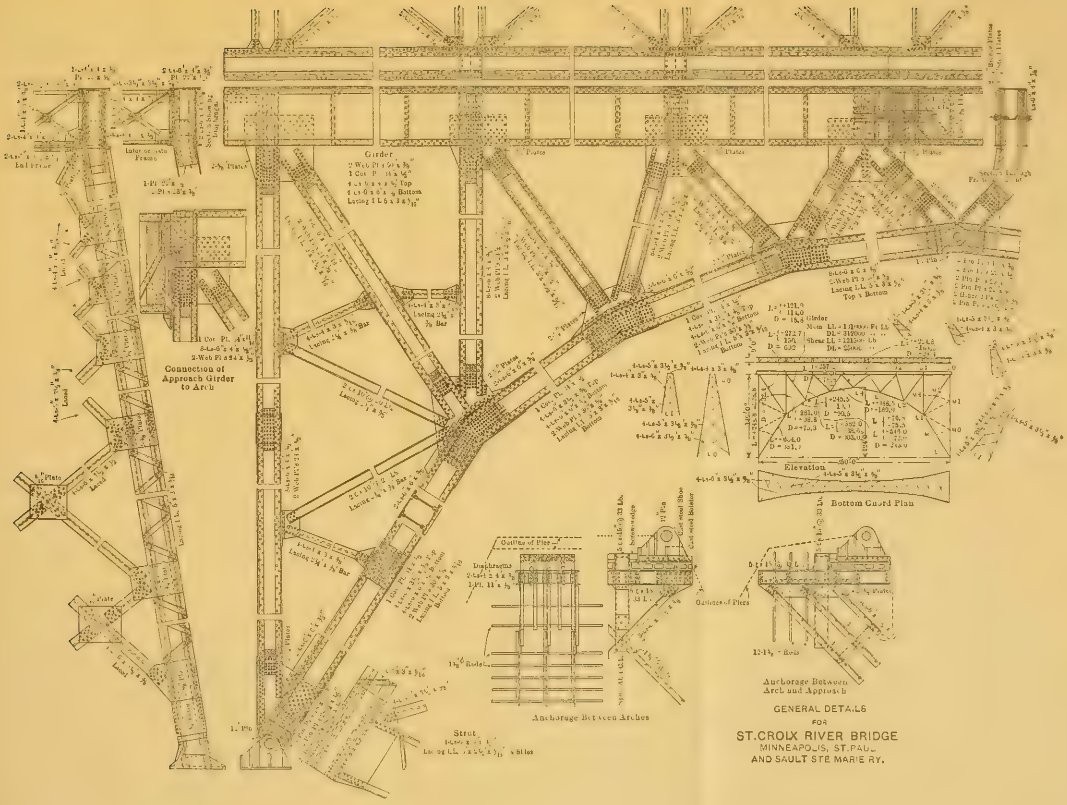
The most difficult part was the erection of the first panel of the end arches. On the east side, a falsework bent was put up, supporting the 100-ft. girder; and, on the west side, the end vertical of the arch was supported on a cob-pile of timber until the end bottom chord could be placed and the connection at the shoe made.

Fig. 2, Plate CXLVI, shows half of the extreme eastern arch. Fig. 1, Plate CXLVII, shows half of the west arch on falsework and the method of placing the frames. Fig. 2, Plate CXLVII, shows the erection of half of the second arch as a cantilever, the other half being built on falsework. Figs. 1 and 2, Plate CXLVIII, show the closing of the fifth arch. This arch was erected without any falsework whatever.

Special Features.—In erecting past the center top chord, it was found simplest to support the center top chords from a timber bent down to the pin and to the outer end outside of the line of the chord, and slide it inward to position laterally after the succeeding chord and diagonals had been erected in place.

In building out the end arches, the compression of the timber falsework allowed the members to drop slightly below grade. The jacking up was done by taking advantage of the temperature changes between morning and noon. At about sunrise the shoe at the skew-

PLATE CXLIX.
PAPERS, AM. SOC. C. E.
OCTOBER, 1911.
TURNER ON
ST. CROIX RIVER BRIDGE.



GENERAL DETAILS
FOR
ST.CROIX RIVER BRIDGE
MINNEAPOLIS, ST.PAUL
AND SAULT STE MARIE RY.

back was wedged out; then, as the temperature increased, the expansion of the steel would raise the span from the falsework and shim wedges would be driven home; then, as the temperature dropped, $\frac{1}{2}$ or $\frac{3}{4}$ in. could be gained at the shoe.

As shown by Fig. 2, Plate CXLVIII, the skewback was arranged as follows: A cast-steel shoe was given a horizontal bearing on a bolster frame built into the concrete. This frame was arranged with a projecting vertical center member, against which the vertical end of the shoe could thrust. Steel blocking was provided between the vertical impost member and the end of the shoe, calculating for a clearance of about 9 in. Screw-wedges were provided for the adjustment of the span, so that this distance could be increased, to raise the crown of the arch, or decreased, if found to be above grade when erected.

In closing the first arches, erected wholly on falsework, this clearance proved none too great to get the shoe in place, and the scheme of jacking by temperature changes enabled the erectors to force it out so that the wedges could be entered.

The adoption of inclined trusses, with bent plate connections to the top chords, leaving the chord in a vertical position, is a somewhat unusual feature in bridge design.

The broad and exceptionally rigid floor system secured in the 50-ft. panels of the structure would seemingly warrant its adoption, from the economic standpoint, in deck bridges where the depth is not sufficient for arch construction. The elimination of floor-beams, floor-beam connections, and the combination of stringers and chords in one member, with ample width of floor, will generally result in a material saving of metal.

The structure was designed for Cooper's *E*-55 loading. Plate CXLIX gives a general idea of the details.

The work was executed under the direction of Mr. Thomas Greene, Chief Engineer of the Minneapolis, St. Paul and Sault Ste. Marie Railway, the writer acting as Consulting Bridge Engineer. The Kelly-Atkinson Construction Company was the contractor for the erection of the work, and the American Bridge Company furnished the steelwork. The concrete work was executed by the Railroad Company. The pile-driving was done by George W. Oakes and Company, of St. Paul, Minn.

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AMERICAN SOCIETY OF CIVIL ENGINEERS
INSTITUTED 1852

PAPERS AND DISCUSSIONS

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THE FLOW OF WATER IN CYLINDRICAL CONDUITS.*

By Sidney A. Reeve, Esq.

This paper was suggested by a perusal (in 1909) of the paper entitled "Experiments at Detroit, Mich., on the Effects of Curvature upon the Flow of Water in Pipes,"† by Messrs. Williams, Hubbell, and Fenkell. It relates to that portion of the subject which treats of the distribution of velocities at various points in the cross-section of a pipe. Although the paper referred to is utilized as a text, the writer's purpose is to raise considerations which apply broadly to the general concept of the flow of water in pipes.

Such flow always occurs with velocities which are greatest near the axis of the pipe and least near its walls. Messrs. Williams, Hubbell, and Fenkell conclude that the distribution of these velocities is such as to be expressed, as a function of the distance from the axis, by an ellipse having the diameter of the pipe as its conjugate diameter. The velocity at the wall is said to be one-half that at the axis, while intermediate velocities vary as $(0.5 + y)\ V_c$, wherein V_c is the axial velocity and y is the abscissa of the ellipse, having its major axis equal to unity and its minor axis equal to the pipe diameter.‡

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* This paper will not be presented at any meeting, but written communications on the subject are invited for publication with it in *Transactions*.

† *Transactions*, Am. Soc. C. E., Vol. XLVII, p. 1.

‡ *Transactions*, Am. Soc. C. E., Vol. XLVII, pp. 63 and 64.

In the *Proceedings* of this Society, the Papers and the Discussions on Papers will hereafter be printed so that each will commence on an odd-numbered page. This is done by special request, in order to enable members who wish to do so to separate the Papers and Discussions for filing under various engineering subjects.

Whether or not this be the true form of the function, there is no doubt that the velocities vary in some way generally similar to that stated. At the same time, the assumption seems to be general, among investigators of the subject, that the lines of flow are usually and naturally straight and parallel with the axis. The fundamental natural fact that water flowing in a conduit cannot proceed along straight parallel lines, under the basic laws of fluid equilibrium, and that it never does so, seems to have escaped from its proper place in the premises of their arguments, as well as from their pitometer observations.

All the filaments of water flowing side by side within a pipe must possess the same hydraulic energy. Energetic equilibrium within the pipe will always direct the flow of each particle in the direction of an equalization of energies, should any external influence upset the balance temporarily or locally. The filaments near the walls, however, are continually subject to such an external disturbing influence, in the form of the frictional resistance of the wall surfaces. Thereby they are constantly kept in a condition of deficit of velocity head. Thence results a continuous fault in the energetic equilibrium.

As the sum of pressure head and velocity head for all filaments must be equal, those near the walls, possessing lesser velocity head, must possess greater pressure head. This, however, is hydrostatically impossible; yet, hydrostatically, it would have to occur, if the filaments were moving in straight parallel lines, therefore the hydrostatic equilibrium becomes unstable, following the instability of the energetic equilibrium.

The water, in order to regain its stability of equilibrium, is forced, by this unbalance of hydrostatic pressure, to abandon its original—or, at least, its hypothetical—straight-line parallelism, and to turn to right or left into a helical path. Since the instability of equilibrium is indifferent as to right or left, in whichever direction it happens to be started it persists insistently, because it finds therein stability of equilibrium.

A similar phenomenon is familiar in the helical outflow of water from a stationary wash-bowl. While the source of the instability in this case—the radially centripetal lines of approach toward the outlet—is somewhat different from the case of frictional flow within a long cylindrical pipe, yet stability of equilibrium is regained in quite the same way; and frictional resistance is also present as a contributory factor, although of minor importance. It is virtually impossible to make the water flow from the wash-bowl in parallelism with the axis of the outlet. It insists on whirling helically to right or left, whichever way it happens to be started; and whichever way it whirls, it regains thereby its stability.

Within the helical whirl the pressure head, acting radially outward, is not everywhere equal. Owing to centrifugal force, it is greater near the periphery. Equilibrium will be found when the rise in radial pressure, due to the greater radius and velocity of the whirl, as it passes from the axis to the wall of the pipe, just counterbalances the loss in velocity head due to the slower progress of the water along the pipe near the walls. The more the axial progress of the water is arrested by friction, the more it whirls, instead of progressing.

The energy of the whirl, however, cannot be all of that disappearing in the form of axial velocity. It must be something less than this, for the frictional resistance must be continually made good. The loss of axial velocity must go to two destinations, namely, the whirl, and the wall friction. The current parallel with the axis is both diverted and retarded by the wall friction. In other words, the oblique velocity along the helical path cannot be any greater, and must be somewhat less, than the maximum, axially-directed velocity in the center. Yet this oblique velocity is itself made up of two components, namely, (*a*) the velocity at any point in a direction parallel with the axis (that reported by the pitometer observations), and (*b*) the transverse velocity of whirl. That is, the helical velocity at any point in the pipe outside of the axis must be less than the velocity in the axis; and, because it is helical, instead of parallel with the axis, its axial component must be less, again, than its complete oblique self.

It is this second discount from the original maximum—the measurable axial velocity—which alone the pitometer measures in the traverse of the pipe away from the axis; but it is the first discount from the maximum velocity only, down to the oblique, helical velocity (only one component of which the pitometer measures), which supplies the energy visible in the whirl.

A mathematical solution of the situation will probably make it clearer. Let Fig. 1 represent the longitudinal section of a cylindrical conduit, having a diameter of 1 ft. Let V_c be the axial velocity therein, represented by the distance from the line, *aa,* to the point, *c.* Let V_w be the velocity, parallel to the axis, of the filaments touching the walls, represented by the distance from the line, *aa,* to the line, *bd.* For the present it is sufficient to assume, as determined by observation, that $V_w = \frac{1}{2} V_c$.*

Let V be the velocity parallel with the axis at any point, *m,* in the cross-section of the pipe, at a distance, *y,* from the axis. Then at every such point the true velocity of the water will be a helical one, *U,* greater than *V,* because including some portion of the tangential component, yet less than V_c, because constantly contributing energy toward the wall. It is the deficit in velocity head of U below V_c which must be made up in centrifugal force, in order to counterbalance the excessive pressure head near the wall; yet this centrifugal force is the result of a tangential velocity which is itself a component of *U.*

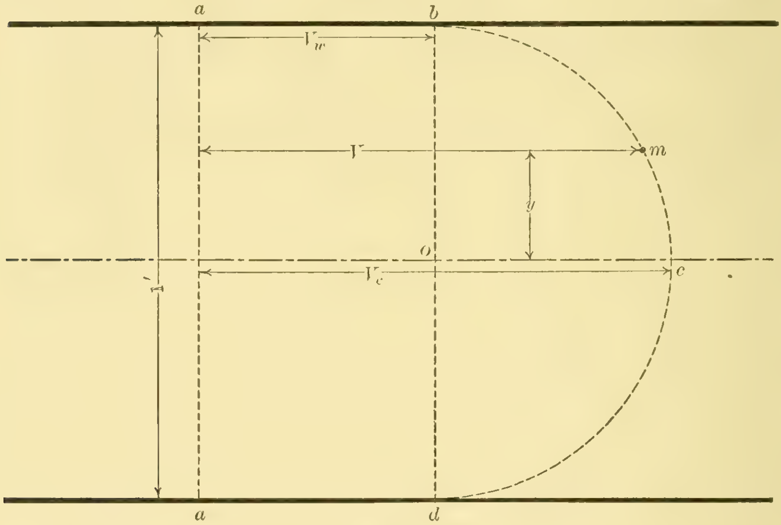

FIG. 1.

Let v be the tangential velocity at any point. Then

$$U^2 = V^2 + v^2 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Therefore, the deficit in linear velocity head which creates the deficit in pressure head necessarily counterbalanced by centrifugal force, is

$$\frac{1}{2g}\left(V_c^2 - U^2\right) = \frac{1}{2g}\left(V_c^2 - V^2 - v^2\right) \ldots\ldots\ldots\ldots (2)$$

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* *Transactions,* Am. Soc. C. E., Vol. XLVII, pp. 63 and 64.

The centrifugal force which must be developed to counterbalance this, if stated in the form of a differential increase as one passes from the axis outwardly, is

$$dP_c = \frac{v^2}{y} dM = \frac{v^2}{y} \frac{dW}{g} = 2 \frac{v^2}{2g} 0.433 \frac{dy}{y} \dots\dots\dots\dots (3)$$

wherein 0.433 is the weight of a prism of water 1 sq. in. in cross-section and 1 ft. long.

According to the paper already referred to, the curve, *bcd,* of Fig. 1 is normally an ellipse. If the horizontal scale for velocities be chosen so that V_c is represented by a length equal to the pipe diameter, the problem will be simplified further by making the curve, *bcd,* a semicircle. As the pipe diameter has already been assumed to be unity, this is tantamount to assuming that the axial velocity, $V_c = \sqrt{2g} = 8.02$ ft. per sec., and that all other axial velocities which might occur in practice would beget phenomena everywhere proportional thereto—an assumption which seems to be justified by the facts now available. In that case,

$$\frac{V}{\sqrt{2g}} = \frac{1}{2} + \sqrt{\frac{1}{4} - y^2} \dots\dots\dots\dots (4)$$

$$\frac{V^2}{2g} = \frac{1}{2} + \sqrt{\frac{1}{4} - y^2} - y^2 \dots\dots\dots\dots (5)$$

and, from Equation 2,

$$\frac{1}{2g} (V_c^2 - U^2) = \frac{1}{2} - \sqrt{\frac{1}{4} - y^2} + y^2 - \frac{v^2}{2g} \dots\dots\dots (6)$$

It is the differential of this equation, converted from head into pressure per square inch by multiplication by the coefficient, 0.433, which must be equal to Equation 3.

From this final equation between Equations 3 and 6, we should be able to derive an equation for v or U in terms of y. The writer found difficulty in evaluating this equation, however, and as it is not one of general value, but is illustrative only of the assumed case of an elliptic form of traverse curve of velocities, its mathematical complexities were dodged by a recourse to graphical methods.

The results are shown in Fig. 2, in which AC represents the axis of the pipe and WW one of its walls. The abscissas of the curve E, measured from AW, give the values for $\frac{V^2}{2g}$. Those of the curve F, also measured from AW, give the values of $\frac{U^2}{2g}$. Those of the curve F

measured from CW give the increment of centrifugal head over the axis, and the abscissas measured between the curves E and F give the values of $\frac{v^2}{2g}$.

Table 1, of values taken from Fig. 2, will also be of aid in realizing the situation. In this table α signifies the angle which a tangent to the helix at any point makes with a line parallel with the axis through the same point. Were the flow in any actual pipe quite in accord with the rigid theory of an elliptical traverse curve on which this argument has proceeded, the angle, α, is the one at which the pitometer should be placed in order to obtain a maximum reading, for that particular distance from the axis of the pipe. Messrs. Williams, Hubbell, and Fenkell speak of noticing negative readings at times,* and of observing, in their investigation, maxima and minima at pitometer positions forming an angle with the axis; but the only angle mentioned is one of 45 degrees.

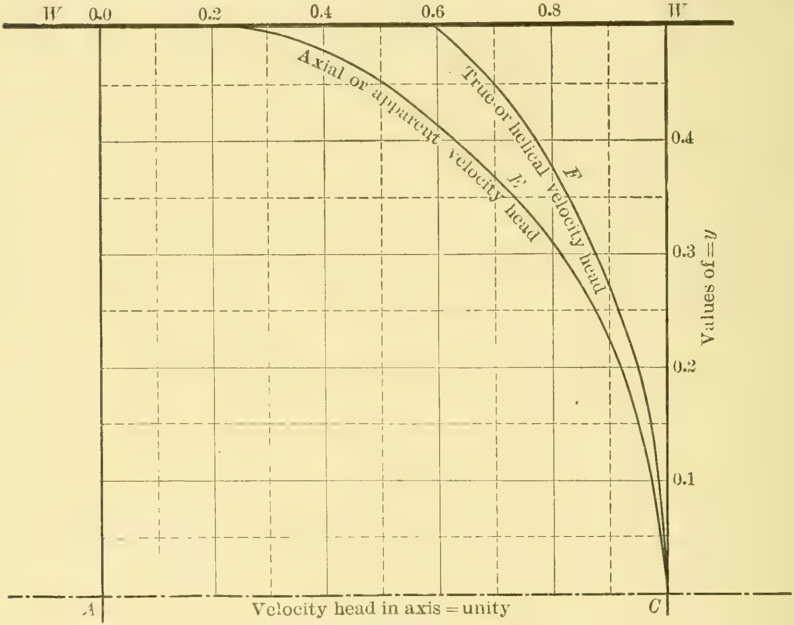

FIG. 2.

The writer, however, does not wish to give the impression that the actual flow is ever along truly helical paths. All that he is trying to emphasize is that the condition of affairs within the pipe must be one of unstable equilibrium, as long as straight and parallel flow is imagined to occur. In reality, this is the one sort of flow which cannot imaginably occur. In avoiding it, however, the water is diverted, not into a smooth, true helix, but into the greatest intricacy of turbulent eddies.

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* *Transactions*, Am. Soc. C. E., Vol. XLVII, p. 56.

TABLE 1.—VALUES TAKEN FROM FIG. 2.

$y =$	0	0.10	0.20	0.30	0.40	0.45	0.48	0.49	0.50
$\frac{V}{\sqrt{2g}} =$	1.000	0.990	0.958	0.900	0.800	0.718	0.640	0.600	0.500
$\frac{U}{\sqrt{2g}} =$	1.000	0.993	0.972	0.934	0.875	0.834	0.803	0.790	0.774
$\frac{v}{\sqrt{2g}} =$	0.000	0.077	0.158	0.249	0.354	0.425	0.480	0.515	0.592
$\frac{v}{y} =$	.....	0.77	0.79	0.83	0.88	0.94	1.00	1.05	1.18
$\tan. \alpha =$	0.000	0.078	0.165	0.277	0.442	0.592	0.750	0.858	1.184
$\alpha =$	0	4° 27′	9° 22′	15° 29′	23° 51′	30° 38′	36° 52′	40° 38′	49° 49′

The fifth row of values, giving the ratio of the transverse velocities of whirl, *v*, to the distance from the axis, *y*, shows a fair degree of constancy. This signifies that the water might whirl, as it progresses, in a fairly homogeneous manner, not generally disturbed by the presence of the many small internal eddies just mentioned, although everywhere locally perturbed.

It will be noticed, too, that this ratio increases steadily and increasingly, as one passes from the axis to the wall. This is shown by Fig. 3. It is natural that this increase should occur, because there must be a continual flow of energy from the general body of water toward the wall; but it is not probable that the rate of increase rises as rapidly near the wall as is shown in Fig. 3, because the wall must have some retarding effect on rotational, as well as on axial, velocities. The form of curve shown is due to the fact that the geometric form of traverse curve specified by the writers quoted becomes tangential to the wall where it intersects the latter, the rate of its loss of velocity head then becoming instantaneously infinite. From all these considerations it appears probable to the writer that the traverse curve is not normally any particular geometric curve. It probably approaches the ellipse more nearly than any other form; but it probably loses its curvature somewhat, as it nears the wall, and intersects the latter at an appreciable, though slight, angle.

The entire situation will be best understood by keeping well in mind the distribution of energies in the mass of water. The mean axial kinetic energy of the water, of course, must remain constant, as long as the pipe diameter remains constant. This means that the supply of energy required for overcoming friction must be derived from a deficit in pressure energy, or head; and this is just what is observed in hydraulic phenomena, as a general fact. Friction reduces the pressure.

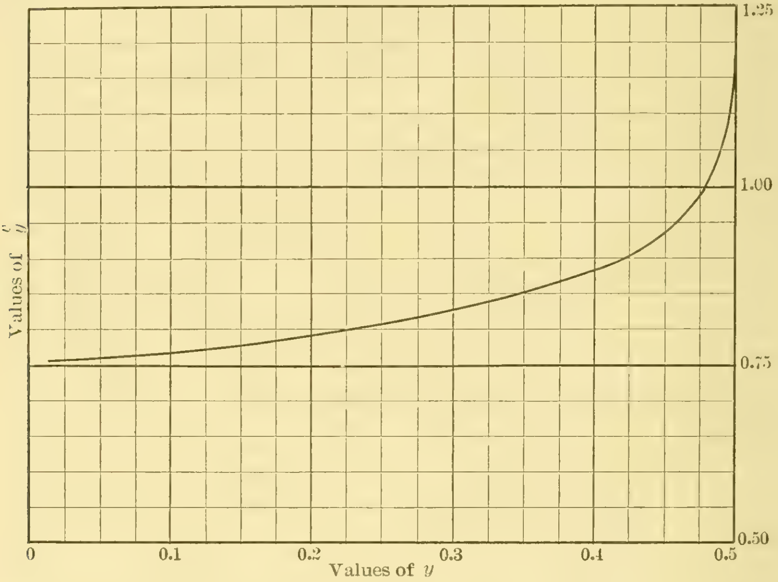

FIG. 3.

Strictly speaking, however, pressure energy cannot directly and of itself overcome friction. It is only motion which can do that. Friction is strictly a function of motion, appearing only when motion appears and non-existent under the greatest pressures if motion be absent. It is merely a name for the retardation of motion by the contact of mass with mass. The familiar hydraulic rule that friction losses are to be deducted from head is a mere convention—of the utmost convenience, and unobjectionable for engineering purposes, but not strictly true—and hence misleading in such an enquiry as the present one, as to the true situation within the water in the pipe.

There is, therefore, a constant disappearance of motion energy along the walls in friction—for friction is overcome by motion energy only as Arnold von Winkelried overcame the Austrian spears, by the extinction of the victor. This continual disappearance of motion energy along the walls, however, begets immediately, not the deficit of pressure head which it must finally become in form, after the books are balanced, but a local surplus of pressure head, due to the retardation of the water.

This surplus pressure can neither compress the water in the center of the pipe, nor (because it acts radially) hasten it along its way. All that it can do is to beget the instability of equilibrium which leads to the whirling action, or to the myriad of tiny eddies into which it breaks up, which has already been described. It is this general whirling motion about the axis which transforms, after the manner of a centrifugal pump, the needed deficit of pressure at its source or center, the axis of the pipe, into a surplus to meet the surplus pressure at the periphery.

There is thus effected a continual flow of energy from the general mass of the water to its periphery. Where the energy departs through the walls as heat; or, if it be still carried along with the water as heat, it is no longer hydraulic energy. The helical whirl in the pipe acts as a centrifugal pump for energy, using water as its working substance, yet discharging none of that water. It is only the energy which is discharged.

The situation may be better grasped by remembering that what is called the pressure of water is nothing but the centrifugal force of the tangential motion of its myriads of rapidly whirling molecules. It is quite natural, therefore, that it should be this form of energy which is called on to set up and maintain that general whirl of the entire mass of water which is needed to overcome friction at the expense of head.

The entire subject is much in need of investigation, in its arithmetrical aspect, by the pitometer men. While such data as have been adduced here suffice to illustrate the general principles of action which must always be kept in mind, in conducting investigations of flow in pipes, yet it must not be supposed that they are reliable quantitative guides for situations other than the assumed premises of the argument.

One purpose of this paper, of educational rather than of practical importance, is to emphasize the fundamental mechanical fact that the natural path of mass in motion is always curvilinear. The straight line is never a natural path of motion. It is always the natural path of force. Mass in motion not only never follows a straight line voluntarily, but it cannot be forced to follow it, except approximately and temporarily, under constraint, with constant and inevitable dissipation of energy. The only occurrence of the straight line in Nature is in the transmission of force through a solid; for neither liquids nor gases confine their transmission of force to straight lines. Indeed, the prime instance of the straight line in Nature—the foundation of all our astronomy and triangulation, and properly the sole basis for our definitions of geometric right lines—is the path of light through the luminiferous ether; and Lord Kelvin says that the luminiferous ether is a solid.

The secondary natural instance of the straight line, the transmission of natural force through solids, civil engineers learned long ago; their structural elements of roofs and bridges are never curved. It is only more recently and reluctantly that mechanical engineers, under pressure from such leaders as Professor Sweet, Mr. John Richards, and others, have learned to confine themselves more exclusively to straight lines.

The converse proposition, the curvilinear nature of all free motion, is thoroughly recognized in all the work of naval architects and hydraulic engineers; but our textbooks on elementary hydraulics, nevertheless, seem to have overlooked the importance of this fundamental fact. The principles of the flow of water in pipes is only a single instance of this.

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AMERICAN SOCIETY OF CIVIL ENGINEERS
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PAPERS AND DISCUSSIONS

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CONSTRUCTION OF THE MORENA ROCK FILL DAM, SAN DIEGO COUNTY, CALIFORNIA.

By M. M. O'Shaughnessy, M. Am. Soc. C. E.

To be Presented December 20th, 1911.

In August, 1906, under a contract with the City of San Diego, the Southern California Mountain Water Company undertook to furnish a supply of water, up to 7 766 000 gal. per day, at the city limits, at the extraordinarily low price of 4 cents per 1 000 gal., from the Lower and Upper Otay Lakes, through 20 miles of pipe line.

Previous to this time the city depended on the pumping plant at the San Diego River, in the Mission Valley, inside the city limits, for its supply. As this water was highly alkaline and the quantity was limited to about 3 000 000 gal. per day, the city was very eager to secure an improved water supply of good quality to supplant the objectionable system, which retarded the growth of the community.

As the volume of water in the Otay water-shed alone was not sufficient to fill the obligations of this contract, the Company undertook to expand its plant and make additions to provide for future increased consumption. For this purpose the Dulzura Conduit was built, in 1907-08, to lead the water from the Cottonwood water-shed

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Note.—These papers are issued before the date set for presentation and discussion. Correspondence is invited from those who cannot be present at the meeting, and may be sent by mail to the Secretary. Discussion, either oral or written, will be published in a subsequent number of *Proceedings*, and, when finally closed, the papers, with discussion in full, will be published in *Transactions*.

In the *Proceedings* of this Society, the Papers and the Discussions on Papers will hereafter be printed so that each will commence on an odd-numbered page. This is done by special request in order to enable members who wish to do so to separate the Papers and Discussions for filing under various engineering subjects.

into that of the Otay, and the construction of the Morena Dam was proceeded with, on the completion of which it was intended to impound the flood-waters of the Cottonwood and gradually pass them into the Otay as required. Table 1 shows the condition of the present system (Fig. 1).

TABLE 1.—RESERVOIR SUPPLIES OF THE SOUTHERN CALIFORNIA MOUNTAIN WATER COMPANY.

Name of reservoir.	Type of dam.	Height, in feet.	Outlet altitude, in feet.	Area submerged, acres.	Capacity, in gallons.
Lower Otay.......	Rock fill...............	150	400	869	13 000 000 000
Upper Otay.......	Arched concrete......	77	521	164	1 090 000 000
Chollas Heights...	Earth and steel plate..	34	385	17	90 000 000
Barrett............	Proposed, not designed	150	1 506	936	15 000 000 000
Morena............	Rock fill...............	265	2 912	1 370	15 000 000 000

Total capacity................44 180 000 000

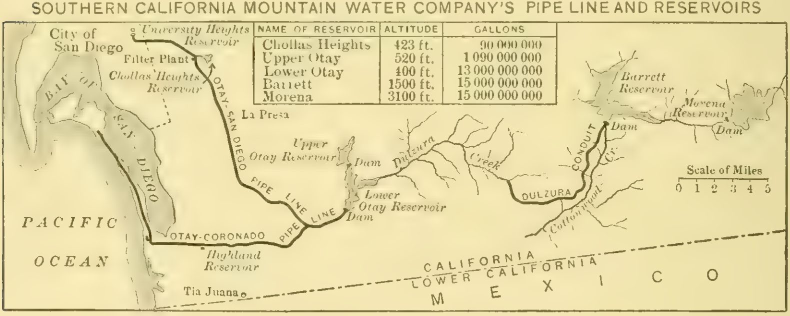

SOUTHERN CALIFORNIA MOUNTAIN WATER COMPANY'S PIPE LINE AND RESERVOIRS
NAME OF RESERVOIR | ALTITUDE | GALLONS
Chollas Heights | 423 ft. | 90 000 000
Upper Otay | 520 ft. | 1 090 000 000
Lower Otay | 400 ft. | 13 000 000 000
Barrett | 1500 ft. | 15 000 000 000
Morena | 3100 ft. | 15 000 000 000
City of San Diego
University Heights Reservoir
Filter Plant
Chollas Heights Reservoir
BAY OF SAN DIEGO
OTAY-SAN DIEGO
La Presa
Upper Otay Reservoir
Dam
PIPE LINE
Lower Otay Reservoir
Dam
PIPE LINE
Dulzura
Creek
DULZURA
CONDUIT
Dam
Barrett Reservoir
Morena Reservoir
Dam
Cr.
Cottonwood
Scale of Miles
0 1 2 3 4 5
PACIFIC
OCEAN
OTAY-CORONADO
Highland Reservoir
Tia Juana
CALIFORNIA
LOWER CALIFORNIA
MEXICO

FIG. 1.

In this part of California it is necessary to store enough water to provide for the consumption for a period of from 5 to 7 successive dry years. The run-off generally takes place from January to May, and the stream beds are dry for the remainder of the year.

The Company's works are on Otay Creek and the Cottonwood River, about 25 and 50 miles, respectively, southeast of San Diego. The Cottonwood water-shed has an area of 250 sq. miles above the Barrett Dam and the Dulzura Conduit Intake—135 sq. miles of which are above the Morena Dam. The Otay water-shed has an area of 100 sq. miles, so that the Company commands altogether 350 sq. miles of clean mountain water-shed covered with wild brush. There are practically no traces of animal life in this region, therefore the quality of the water is perfect. On account of the purity of the water furnished, San Diego, at the present time, has the lowest death rate in the State of California, and is absolutely free from typhoid, except for cases imported from outside districts.

Rainfall and Run-off.—Prior to the last five years, no records were kept of the rainfall or run-off on the Company's properties. Since that time, however, rain gauges and weirs have been established, and daily records have been kept, from which Table 2 has been compiled.

TABLE 2.—RAINFALL.

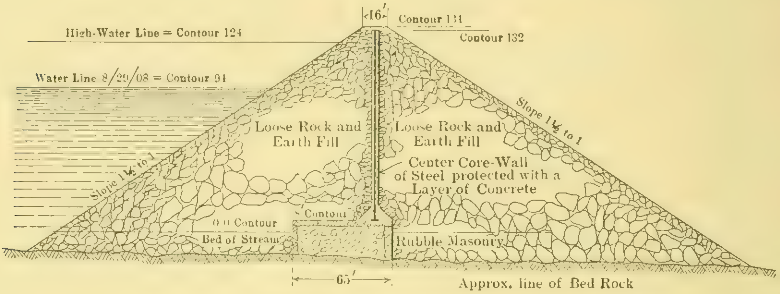
Year.	Barrett Dam rain gauge. Elevation, 1 700 ft.	Morena Dam rain gauge. Elevation, 3 300 ft.	Run-off, in gallons, from Cottonwood water-shed at Barrett, 250 sq. miles area.
1906........	29.94 in.	34.73 in.	19 506 000 000
1907........	12.79 “	18.56 “	11 080 000 000
1908........	16.82 “	20.56 “	4 227 000 000
1909........	24.54 “	32.98 “	9 414 000 000
1910........	11.28 “	13.94 “	5 500 000 000

Table 3 shows the catchment on the water-shed adjoining to the north, which supplies the Sweetwater Dam, and on which accurate records have been kept for more than 20 years.

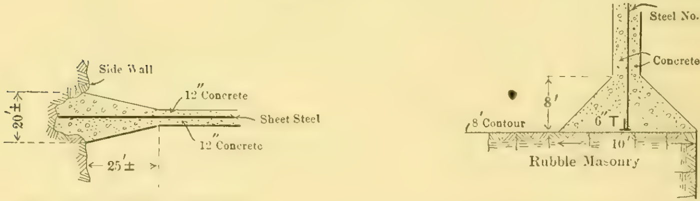
TABLE 3.—RUN-OFF, SWEETWATER WATER-SHED.

Season.	Rainfall, in inches, for each season at Sweet-water Dam.	Run-off, in gallons.	Season.	Rainfall, in inches, for each season at Sweet-water Dam.	Run-off, in gallons.
1887–88	.....	2 302 581 600	1899–00	5.54	0
1888–89	13.53	8 250 155 100	1900–01	7.03	270 507 609
1889–90	13.53	6 707 804 400	1901–02	4.86	0
1890–91	12.65	7 045 938 900	1902–03	5.72	0
1891–92	9.88	2 024 886 600	1903–04	6.39	0
1892–93	11.62	5 312 142 000	1904–05	15.55	4 495 392 000
1893–94	6.20	437 124 600	1905–06	15.52	11 434 500 000
1894–95	16.19	23 983 700 400	1906–07	12.88	9 801 000 000
1895–96	7.29	431 244 000	1907–08	10.50	1 233 977 700
1896–97	10.97	2 251 289 700	1908–09	11.76	3 910 212 000
1897–98	7.05	1 306 800	1909–10	10.87	2 859 342 500
1898–99	5.05	80 041 500	1910–11	10.03	1 095 836 900
Total catchment in 7 years, 1897–1898 to 1903–1904......................					351 855 900

History of the Works.—The Lower Otay Dam (Fig. 2) was commenced in 1887, and a masonry base, 62 ft. wide, 28 ft. high, and extending 160 ft. across the valley of the Otay River, was built with the intention of making it a foundation for a masonry dam. The expense of the contemplated structure alarmed the owners, and they changed the type of construction to that of a rock fill dam with a central diaphragm of ¼-in. steel plate, protected on each side by 1 ft. of concrete. This dam was the first of the kind ever constructed, and has been described many times in technical publications. Operations on this new scheme were commenced in October, 1894, and finished on August 18th, 1897, when the dam was completed to the 130-ft. level above the old stream bed. The top of the dam is 615 ft. long and 15 ft. wide. The rock, taken from quarries adjoining, was


16′
Contour 131
Contour 132
High-Water Line = Contour 124
Water Line 8/29/08 = Contour 94
Slope 1½ to 1
Loose Rock and Earth Fill
Loose Rock and Earth Fill
Slope 1½ to 1
Center Core-Wall of Steel protected with a Layer of Concrete
Contour
0 0 Contour
Bed of Stream
Rubble Masonry
65′
Approx. line of Bed Rock

CRCSS-SECTION OF LOWER OTAY DAM



DETAIL OF SIDE SEAL OF CENTER CORE

DETAIL OF LOWER OR BOTTOM SEAL OF CENTER CORE

FIG. 2.

dumped on both sides of the core by Lidgerwood cableways, care being taken not to disturb the core when placing the rock adjacent to it. The slopes of the dumped rock are a little steeper than 1½ horizontal to 1 vertical. The dam has never been subjected to a full head of water, which would be 124 ft., or at the level of the spillway. In June, 1909, however, there was a depth of 109 ft. 6 in., which was lowered in December to 102 ft. Owing to the additional supply of water conveyed by the Dulzura Conduit, the lake level rose in May, 1910, to 119 ft. 6 in., and at present is about 110 ft. The high level of the water caused the saturation, for the first time, of the soft materials which were mixed with the rock from the quarry, and the result was a slight settlement of the fill on the up-stream side of the core—a condition naturally to be expected, as the fill is not composed entirely of clean rock. Additional materials have been hauled, however, to keep the top of the dam level.

Through this dam there has always been a slight leakage, and this fluctuates with the varying head in the reservoirs, as the formation is in a seamy porphyry, but it has not yet attained any serious proportions. This is one of the strongest objections to structures of this type, as it is not possible to determine the exact location of any leakage through the dam without endangering it by prospecting in the mass near the thin core.

As the area of the water-shed of Otay Creek above the dam is only about 100 sq. miles, with an average altitude of only 1 600 ft., the precipitation is light, and, except in occasional years, the run-off is only sufficient to fill the reservoir partly. To supplement and meet the requirements of the growing city of San Diego, the Company has built the Dulzura Conduit to divert the water from the Cottonwood. This drains an area of about 250 sq. miles of mountain water-shed (Fig. 1), which lies entirely in a granite formation. The Dulzura Conduit starts about 2 miles above the site of the Barrett Dam, and passes through it by a tunnel at an elevation of 60 ft. above the stream bed, or about 1 506 ft. above sea level, and is supported along the southerly slope of Lyon's Peak to Dulzura Divide, through which it passes through a tunnel 970 ft. long, discharging into Dulzura Creek, which flows into the Lower Otay Lake.

This conduit is 13.38 miles long. It was commenced in August, 1907, and was completed on January 3d, 1909, under the writer's direction. It was built with a slope of 4 in 5 000, and consists of three types of construction, concrete-lined aqueduct, granite tunnels, and flumes. It has a carrying capacity, checked by weir measurements at its western terminus, of 44 000 000 gal. per 24 hours. Through the solid granite there are seventeen tunnels, 6 ft. wide and 7 ft. high, ranging in length from 40 to 2 060 ft., their total length aggregating 9 219 ft. The concrete-lined portion is 56 957 ft. long, lined on the sides with concrete from 4 to 6 in. thick. The bottom is not lined, as the materials found are either hard granite or impervious hardpan. The average width of this section is 5 ft., and its depth is 4 ft. 2 in. The side slopes are 3 in. horizontal to 1 ft. vertical. The length of the flume is 4 490 ft., and this is contracted to the shortest possible limit, owing to the fact that it is subject to destruction by fires, which in a dry summer and fall burn across the brush-covered country through which the conduit passes. The entire loss from seepage and evaporation does not exceed 3% of the capacity of the conduit.

Barrett Dam.—The site of the Barrett Dam is about 1½ miles below the junction of Pine Creek and Cottonwood Creek, and occupies a mountain gorge, with solid granite walls on each side. There is a drainage basin of 250 sq. miles above this dam site, and the Dulzura Conduit now passes through it. Extensive exploration and engineering studies have been made, and are still being prosecuted, to ascertain the best type of dam to build at this point. With a structure 150 ft. high, about 15 000 000 000 gal. of water can be impounded. The Dulzura Conduit has been constructed so that it passes through this dam site in a tunnel cut out of the solid granite, through which the water from the permanent outlet will be eventually passed. A wagon road, 12 miles long, has been cut out of the solid mountain side from the Barrett Dam to Dulzura, paralleling the conduit, so that cement and other materials for its construction can be handled economically.

Cottonwood Water-Shed.—The tributary water-shed of 250 sq. miles ranges in altitude from 1 500 to 6 000 ft., and probably averages 3 600 ft. The precipitation on this water-shed may ordinarily be expected to be from 10 to 20 in. greater than that of San Diego, due to altitude; and in some years it may be from 30 to 35 in. greater. The mean precipitation for San Diego for forty years, from 1850 to 1890, was 9.86 in., ranging from 3.02 in. in 1863, to 27.59 in. in 1884. To fill the reservoir to the 150-ft. contour will require 47 970 acre-ft., or 2 084 000 000 cu. ft., which would be supplied by an average rainfall of 3.6 in. from the water-shed. Under favorable conditions, this depth of run-off would be expected from an annual rainfall of 24 in., and, at times, may be the product of only 15 in. precipitation, depending largely on the distribution of the storms, and the frequency with which they succeed each other.

Morena Rock Fill Dam.—The other great dam of the Southern California Mountain Water Company, which this paper is intended

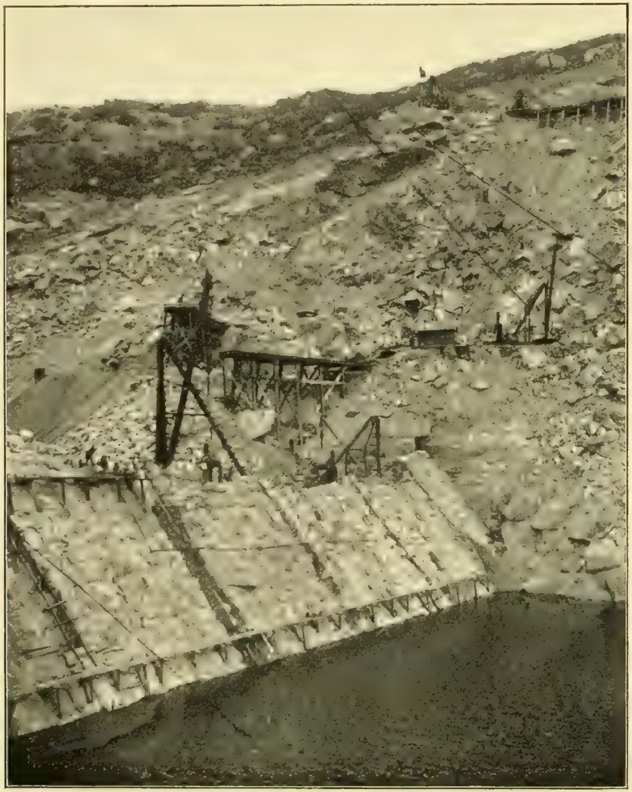


FIG. 1.—MORENA ROCK FILL DAM, LOOKING NORTHEAST.

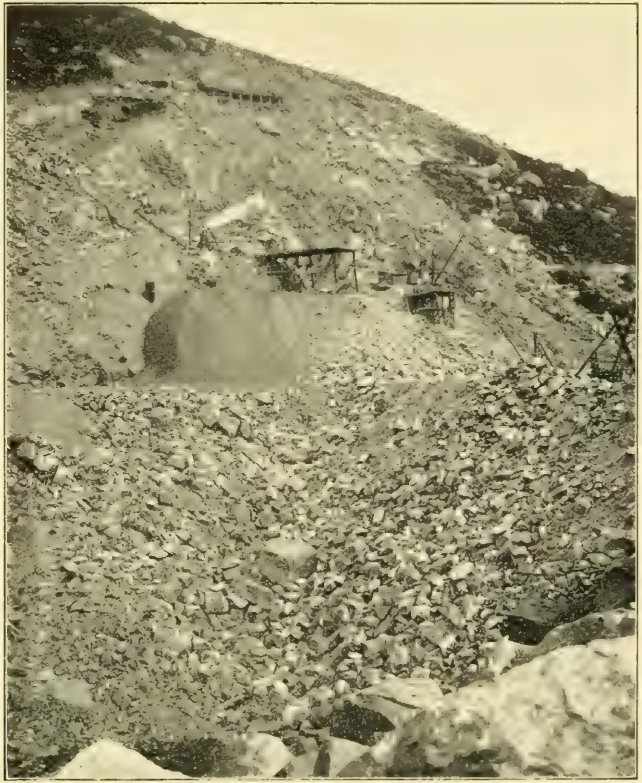


FIG. 2.—MORENA ROCK FILL DAM, SHOWING LOOSE ROCK ON LOWER SLOPE, AND QUARRY REFUSE WASTED OUTSIDE THE DAM SECTION.

to describe, is 10 miles east of the Barrett Dam site, and on one of the streams which unite just above Barrett at an altitude of 3 100 ft. above sea level. It is 35 miles in an air line southeast from San Diego, and about 7 miles north of the Mexican boundary line. The dam is a rock fill structure (Figs. 3 and 4) facing a narrow cañon and lying between massive granite cliffs which tower 100 ft. high on the brink of a precipitous fall or cataract where the Cottonwood stream takes a plunge of 1 000 ft. within a distance of 2 miles. This dam forms one of a series of five to be constructed by the Company to impound water for the municipalities of San Diego and Coronado, and, ultimately, when an adequate reserve supply of water for domestic consumption is stored in the different reservoirs, to furnish water for the irrigation of extensive areas of frostless mesa land.

The Morena cañon is filled throughout with enormous boulders, and, at the site of the dam, a narrow fissure eroded by the stream was found to be 112 ft. below the stream bed at that point. A wall of rubble concrete, 36 ft. thick at the bottom and 12 ft. thick 30 ft. above the stream bed, was the first construction work done in 1896, when the project of building this dam was launched. At that time it was intended to build the water face on a slope of 1⅓ to 1, and the down-stream slope 1½ to 1; the top width was to be 20 ft. It was also intended to pave the water slope of the rock fill with an asphalt concrete, which was thought to be durable and impervious. Work was suspended in April, 1898, however, after the toe wall, up to the 30-ft. contour, had been completed and about 120 000 cu. yd. of rock fill had been placed, out of a total of 306 000 cu. yd. required to complete the dam to the prescribed cross-section. On resuming construction, on May 6th, 1909, it was decided to change the upper slope, from the top of the completed toe wall up to the 120-ft. contour, to 9 horizontal to 10 vertical, and make it, from the 120-ft. contour to the top of the dam—150 ft.—½ horizontal to 1 vertical. It was decided to alter the character of the work by placing large masonry blocks of roughly dressed granite, from 6 to 10 tons in weight, selected from the rock piles, on the up-stream face of the dam, and have them well bedded and set in cement mortar composed of 1 part cement to 2½ parts sand, and behind this masonry skin, about 7 ft. thick, to place all the stone, by hand and derrick, for a width of

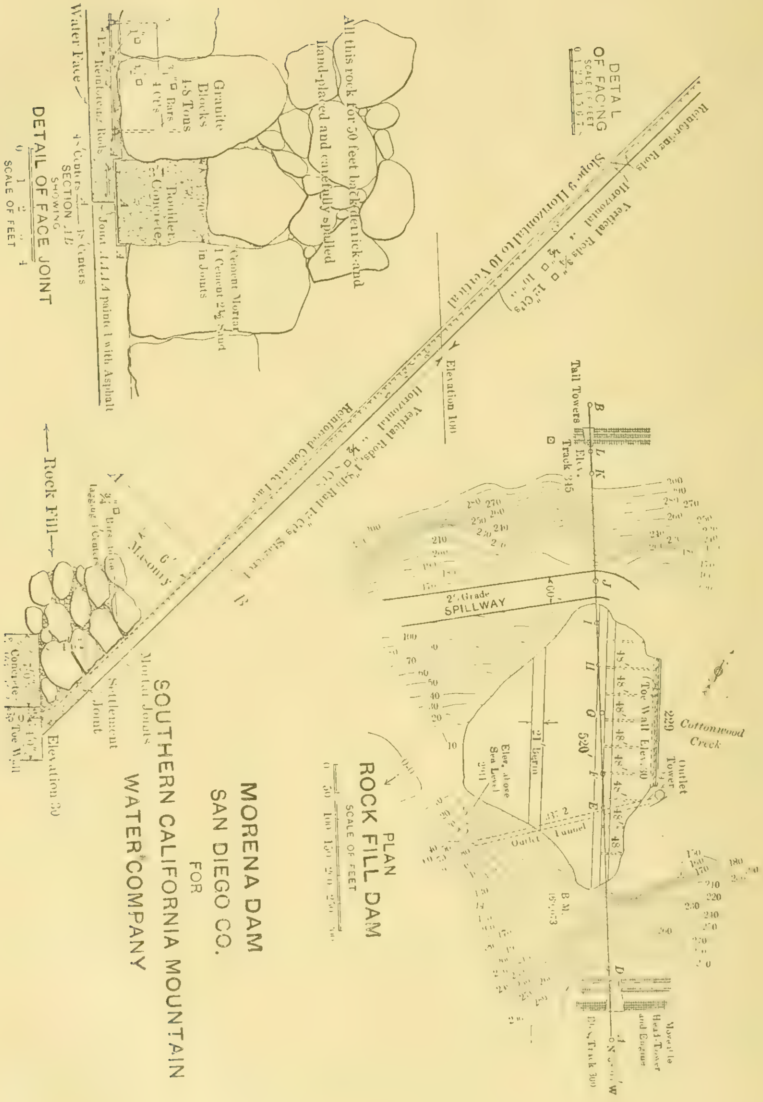

MORENA DAM
SAN DIEGO CO.
FOR
SOUTHERN CALIFORNIA MOUNTAIN
WATER COMPANY
PLAN
ROCK FILL DAM
SCALE OF FEET
DETAIL OF FACING
SCALE OF FEET
DETAIL OF FACE JOINT
SHOWING
SECTION AB
SCALE OF FEET
Water Face
Reinforcing Rods
Granite Blocks 4-8 Tons
All this rock for 30 feet back derrick and hand-placed and carefully spalled
Cement Mortar 1 Cement 2½ Sand in Joints
Boulder 1:3 Concrete
Joint A.A.A.A. painted with Asphalt
Reinforcing Rods
Slope 6 Horizontal to 10 Vertical
Horizontal
Vertical Rods
Elevation 100
Reinforced Concrete Face
Vertical Rods
Horizontal
Masonry
Rock Fill
Mortar Joints
Settlement Joint
Elevation 30
Concrete
Toe Wall
Tail Towers
Elev. Track 315
SPILLWAY
2% Grade
Toe Wall Elev. 30
220
Outlet Tower
Cottonwood Creek
21' Berm
520'
Elev. above Sea Level
Outlet Tunnel
B.M.
Movable Head-Tower and Engine
Elev. Track 300

FIG. 3.

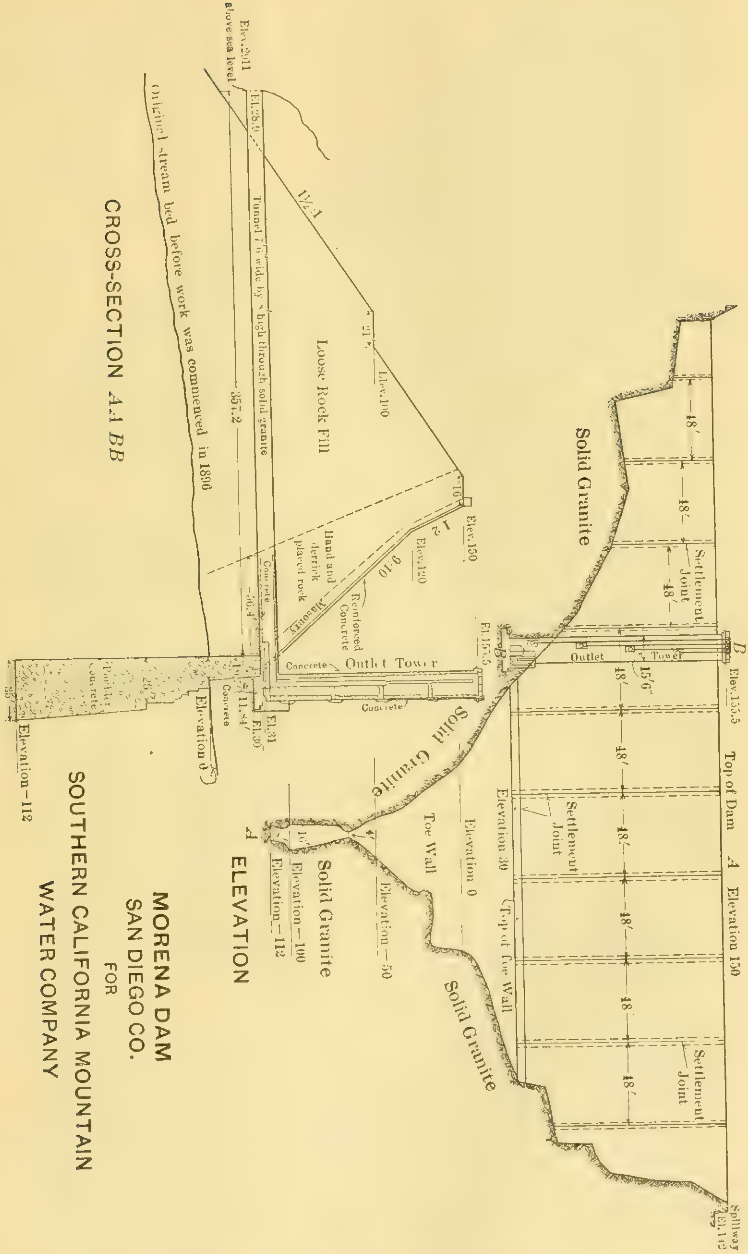

MORENA DAM
SAN DIEGO CO.
FOR
SOUTHERN CALIFORNIA MOUNTAIN
WATER COMPANY
CROSS-SECTION AA BB
ELEVATION
Elev. 2911 above sea level
El. 28.9
Original stream bed before work was commenced in 1896
Tunnel 7'6" wide by 8' high through solid granite
1½:1
21'
Elev. 100
Loose Rock Fill
357.2
16'
Elev. 150
1:2
Elev. 120
9:10
Hand and derrick placed rock
Masonry
Reinforced Concrete
Concrete
56.4'
Outlet Tower
El. 155.5
Concrete
El. 31
El. 30
11.4'
Elevation 0
Sporting concrete
35'
Elevation −112
Solid Granite
48'
Settlement Joint
Outlet
Tower
15'6"
B
Elev. 155.5
Top of Dam
A
Elevation 150
Elevation 30
Elevation 0
Toe Wall
Top of Toe Wall
Elevation −50
Elevation −100
Elevation −112
4'
10'
Spillway El. 142

Fig. 4.

50 ft. back from the face, in order to provide consistent support for the skin. The top of the dam is 16 ft. wide, and is crowned with a 3-ft. concrete coping to provide for wave wash. The back slope is 1½ horizontal to 1 vertical, with a berm of 21 ft. at the 100-ft. contour to provide for future extensions in raising the dam. This berm was practically created by the alteration of the face slopes, which originally contemplated a flatter water slope.

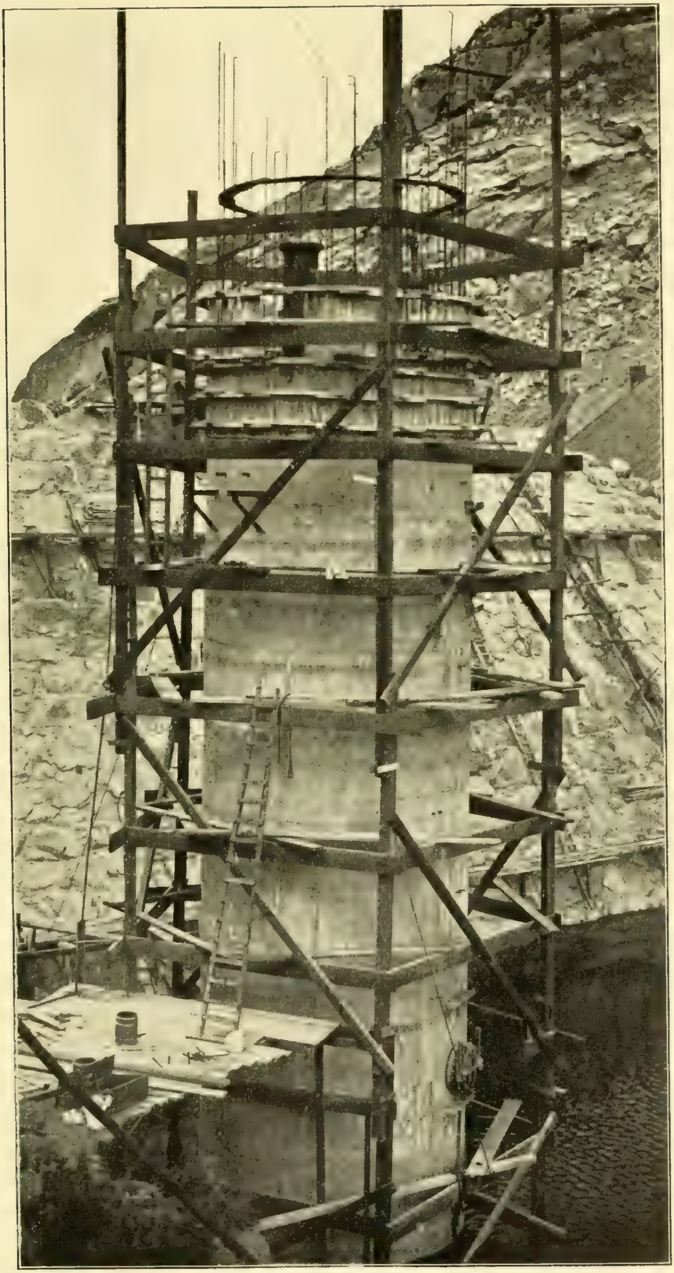
In the original work, done 12 years ago without proper continuous technical supervision, there was a little recklessness in the disposition of the materials in the dam, and it was necessary, when the work was resumed in 1909, after a thorough examination, to tear out a large part of the old fill behind the toe wall, remove all loam or other objectionable material, and rebuild with a clean, well-placed rock fill.

At one time, after seeing the nature of the old construction, the writer was almost committed to the idea of letting the old mass stand and, as the additional rock was being placed, hydraulicking a granite surface soil from the adjoining hills into the interstices as the dam was being raised. After a thorough discussion of the matter, however, with many brother engineers, and especially with George L. Dillman, M. Am. Soc. C. E., who seemed to have a clearer conception than any one interviewed as to the requirements of a rock fill dam, the present method of procedure was decided on; that is, to construct a water-tight skin for the face of the dam and keep the rock fill absolutely clear of any soil or silt, and thus provide free drainage for any possible leaks which might occur in the future, without impairing the integrity of the mass by washing out sand or other solvent materials.

To obviate further any serious cracking of the skin, which might be caused by settlement, grooves, 3 ft. square, and 48 ft. from center to center, were placed in the masonry, and into these concrete has been poured and brought to an absolutely smooth surface, the general average plane of which projects 3 in. beyond the general face of the masonry.

In the future it is proposed to place reinforced concrete slabs, averaging 1 ft. in thickness, on the face of the masonry and attached to it by ¾-in. iron rods, 4 ft. from center to center. These slabs will be joined with ¾-in. water-tight settlement joints, poured with a sand asphalt along the center line of, and resting on, the concrete grooves

PLATE CLI.
PAPERS, AM. SOC. C. E.
OCTOBER, 1911.
O'SHAUGHNESSY ON
MORENA ROCK FILL DAM.



Reinforced Concrete Outlet Tower, Morena Reservoir.

previously mentioned. A slot, 1 ft. wide and 5 ft. deep, was left in the old toe wall, Fig. 3, into which the reinforced concrete facing has already been nested and constructed up to the 42-ft. contour, or 12 ft. above the old toe wall. The zero of the dam levels, as shown by the drawings, is the surface of the original stream bed before work was begun.

This toe wall had a leakage of 57 800 gal. per day in 1898, after it was built, with a head of water up to the 30-ft. contour. It will be noticed from Table 4 that the present leakage, under a head of 65 ft., is only 33 604 gal. per day. This is now measured at a bedrock outcrop in the cañon below the dam and about 1 000 ft. from it.

TABLE 4.—LEAKAGE OF MORENA RESERVOIR.

Date.	Depth of water, in feet.	Leakage, in gallons per 24 hours.
January 13	42	29 727
March 6	48	97 226
March 8	50.5	97 226
March 11	53	120 596
March 14	55	104 152
March 19	57.15	104 152
March 25	58.5	104 152
April 5	60.37	70 448
April 10	61.27	70 448
April 16	61.97	70 448
April 19	62.3	51 053
April 25	63.0	46 529
May 1	63.5	51 053
May 7	63.93	51 053
May 12	64.25	46 529
May 14	64.37	51 053
May 22	64.78	37 481
June 5	65.33	33 604

As the freight rates from San Diego to Morena—a distance of about 60 miles by wagon road, with maximum grades of 16% to be overcome—run up to about 1 cent per lb., it has been imperative to reduce to a minimum the quantities necessary to make a first-class job, on account of the excessive cost of hauling at the dam site.

The cañon walls at the dam site are all of clean, hard granite, singularly free from fissures and seams, and the width between them is only 80 ft. at the stream bed and 520 ft. at the 150-ft. contour—the level of the top of the present completed dam. It has been necessary to add about 186 000 cu. yd. of rock to the original 120 cu. yd., in order to complete the dam to the prescribed cross-section. Construction operations were prosecuted with two Lidgerwood cableways, which were operated from towers about 300 ft. above the stream bed. The fixed cable was 2½ in. in diameter and 1 350 ft. long, covering the lower slope of the dam. The other cable was mounted on movable trucks, Fig. 3, which had a movement of 170 ft. on tracks at right angles to the axis of the dam, and was able to cover the whole of its water slope; this cable was 2¼ in. in diameter and 1 100 ft. long. Each cable was able to handle readily loads up to 10 and 12 tons. All the large rock was chained, and was either picked up by the cable directly or delivered to it by feeding derricks, and transferred by the cable to the fill; the smaller rock was carried in 6 by 8-ft. skips, each capable of carrying 2 cu. yd. It was possible to move the track trolley cable into a new position in about 2 hours, which made a very convenient arrangement for moving the stone from the quarries directly into the dam work, where it was re-handled by derricks for the face masonry and back-filling.

Signaling Apparatus.—In order to control the rapid operation of cables and the exact delivery of rock at certain points of the dam, and to communicate directions to the operating engineers, who were unable to see the work, a new system of signaling was devised. The system of bells used in the old days was abandoned, and an annunciator consisting of a box having ten compartments, each 8 by 8 in. deep, was placed within view of the engineer. The front of each compartment was closed by a pane of frosted glass and on these the following signals were painted: "HOIST", "LOWER", "GO OUT", "COME IN", "FAST", "SLOW", "STOP", and three spare spaces were left for special signals. At the back of each compartment were mounted two Edison keyless wall sockets with 16-c-p., 110-volt lamps. The lamps were wired with a common return wire and an individual wire for the other terminal of each lamp, making 11 wires in all. These wires were of No. 14 copper, covered and cabled, and the outside was protected by jute braid. Each flexible cable was 650 ft. long, and could readily be moved to any favorable position on the south or operating end of the dam. At the signaling end of the cable, ten switches were mounted and normally held open by a spring requiring the pressure of the operator's fingers to close it. The switches were mounted on an insulated base in such a way that the leads were brought into them without coming into contact with the wooden framework. A 1¼-kw., 125-volt, direct-current, compound-wound generator was used, operating at a speed of 1 650 rev. per min. The generator

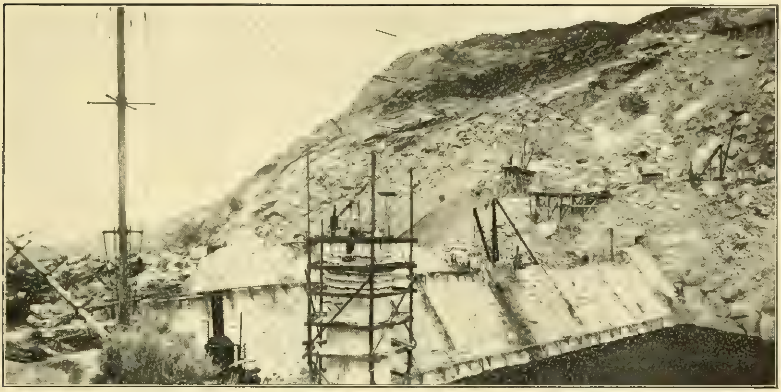


FIG. 1.—ROCK FILL DAM, MORENA RESERVOIR.

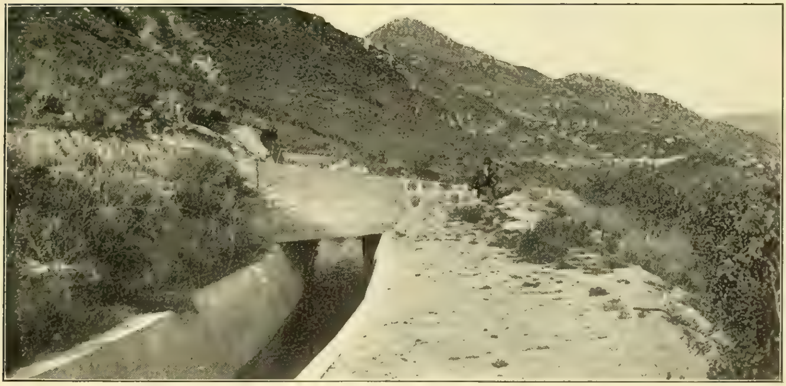


FIG. 2.—DULZURA CONDUIT, NEAR ITS WESTERN END.

was driven by one C. H. Dutton, 5-h.p., vertical, steam engine, at a speed of 300 rev. per min. The engine was supplied with steam tapped from one of the boilers of the big Lidgerwood engines. By this system, a man, with the switch-signal board, was moved around the dam to the most effective points for observing the control and placing of rock as the work progressed, without interfering with guy wires and absolutely preventing accidents, for, in 2½ years of operation, not a man was injured because of any confused signals.

Blasting Rock.—In the construction work of 1896 and 1898, large blasts of powder were used indiscriminately in the adjoining hills to break up the solid granite for handling. Powder was used somewhat generously, as at that time the Company obtained it at the very low contract price of 5 cents per lb. As the price of Judson powder was raised to 8 cents in 1909, and other high-grade powders proportionately, a very careful study of the whole formation surrounding the dam was made before deciding to break rock for the new work. The whole formation in the nearby hills, from which the material for the dam was taken, is a solid granite, and as the cableways were fortunately placed at such a high elevation, 300 ft. above the dam site, a splendid opportunity presented itself for making a mass shot with a large charge of powder without endangering in any way the formation supporting the dam.

A careful study of the rock formation suggested the following means of attack: North of the spillway, Fig. 5, an open cut, 100 ft. long, 12 ft. wide, and about 40 ft. deep, was made at the toe of an old quarry. Parallel to this, and 100 ft. distant, a 4 by 5-ft. tunnel drift, 115 ft. long, was driven into the solid granite, and 70 ft. back from the portal a small chamber, *Y,* depressed below the level of the bottom of the drift, was excavated and made large enough for a 3¼-ton powder charge. At the extreme end of the tunnel drift, a chamber, *X,* 8 by 8 by 14 ft., depressed below the floor and staggered to the left from the general direction of the tunnel, was excavated, and in it a 16.225-ton powder charge was placed. The grade of the tunnel drift was also made 10 ft. above the level of the open cut, conforming to the natural dip of the formation, which was about 10° to the southwest. This layout was designed to throw the broken rock into the area above the open cut, and it was accomplished successfully by the explosion, which took place on August 30th, at 4.20 P. M.

In the large chamber there were 571 50-lb. boxes of 7% and 9% "Champion" powder, 38 boxes of No. 2, 40% dynamite, weighing 2 000 lb., and 40 boxes of No. 1, 60% dynamite, weighing 1 900 lb., in all 32 450 lb., or 16.225 tons. In the smaller chamber there were 100 boxes of 7% "Champion" powder, weighing 5 000 lb., and 30 boxes of No. 2, 40% dynamite, weighing 1 500 lb., in all 6 500 lb., or 3.25 tons.

Cost of Shot.—The detailed costs were as follows:

Tunnel drift and loading	$2 478.15
Open cut	3 499.80
Powder in chambers	3 116.00
Total	$9 093.95

From this sum must be deducted 1 400 cu. yd. of solid rock excavated from the cut and the tunnel, worth $1 400, which left a net cost of $7 693.95, or 4.274 cents per ton for 180 000 tons.

Description of Loading.—In large blasts where powder forms the bulk of the charge, it is preferable to sink pits below the floor level of tunnels or drifts to hold the charges, on account of the greater facility with which a loose powder is loaded into a pit, since greater compactness of the charge is obtained by the men in the pit constantly treading the powder while placing the charge in position. In addition, the sides of a pit offer greater resistance than it is possible to obtain where the powder is loaded directly into the end of the tunnel or drift. This greater resistance offered by the pit is of the utmost importance because it determines the quantity as well as the quality of the explosive necessary, and maximum results will be obtained only where the powder has been confined until the maximum pressure has been attained. The seemingly large primers of dynamite used in this blast, *viz.*, 2 000 lb. of 60% and 1 900 lb. of 40% in the tunnel pit, *X*, and 1 500 lb. of 40% in the drift pit, *Y*, were used first to obtain instantaneous maximum pressures, this being dependent on the rate or speed of detonation of the dynamite, and secondly, for their percussive action. Of course, the rate of detonation and percussive action of the dynamite greatly outstrip the maximum pressure developed by the powder.

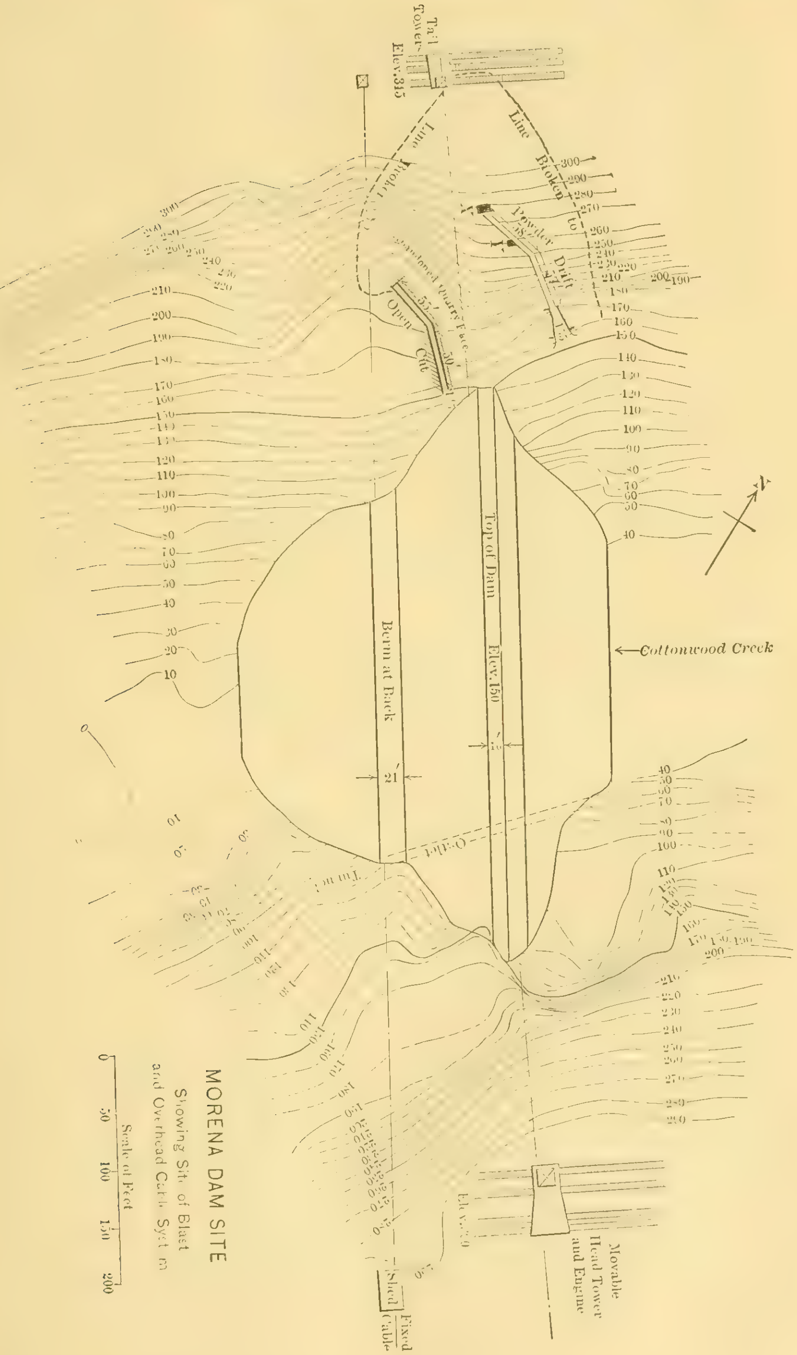

Tail Tower Elev. 315
Line Broken
Line Broken to Powder Drift
Abandoned Quarry Face
Open Cut
55
50
48
44
Top of Dam Elev. 150
15
Berm at Back
21
N
Cottonwood Creek
Outlet
Tunnel
Elev. 290
Movable Head Tower and Engine
Shed
Fixed Cable
MORENA DAM SITE
Showing Site of Blast and Overhead Cable System
Scale of Feet
0
50
100
150
200

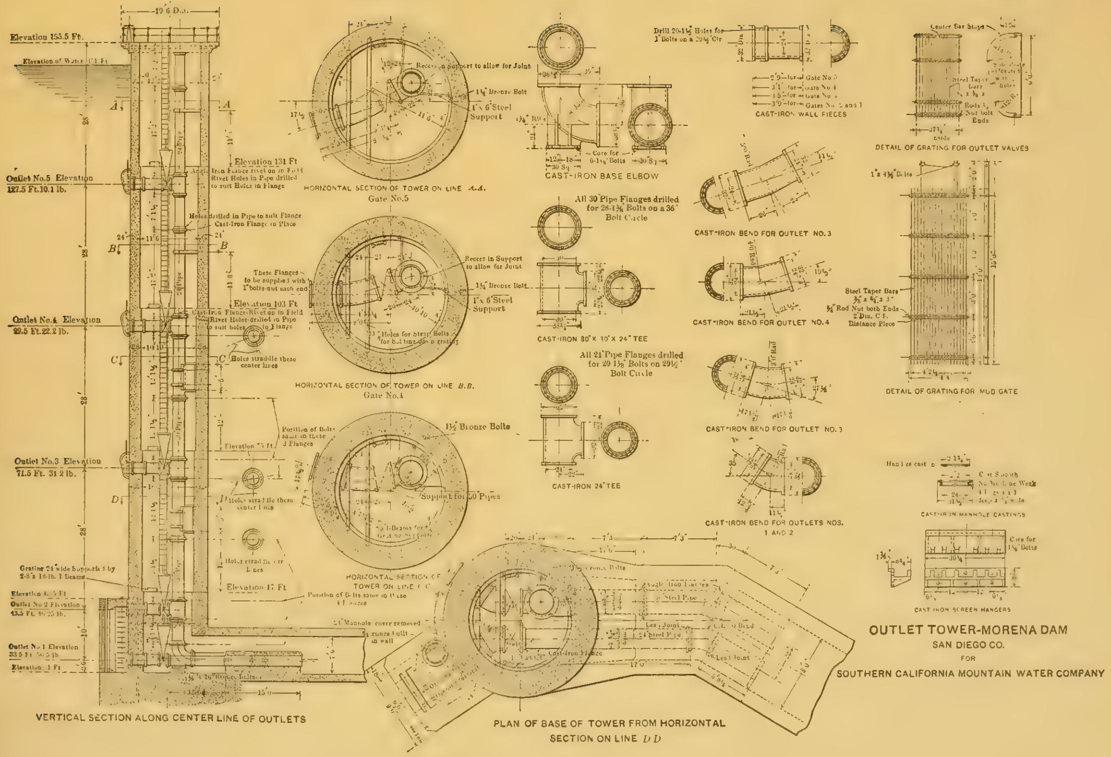
FIG. 5.

The first step in charging the tunnel pit, *X*, was the introduction of about 10 000 lb. of powder, then 2 000 lb. of 60% dynamite in a semi-circle was stacked, two boxes high, in contact with the west wall of the pit, then 1 900 lb. of 40% dynamite was stacked in a similar manner against the east wall of the pit. The percussive action of these primers was to start a break or shear in the rock about 2 ft. below the tunnel floor and in a plane parallel with it, allowing the more slowly forming gases of the powder to expand horizontally, thus giving a greater horizontal purchase and preventing the formation of a crater or blow-out. The remainder of the charge of powder was placed on top of the dynamite primers, all spaces being filled completely with the loose powder. The drift pit, *Y*, was loaded first with 2 500 lb. of loose powder. Then a primer of 1 500 lb. of 40% dynamite was stacked, two boxes high, along the north wall of the pit on top of the powder, with the intention of starting a break or horizontal shear in the direction of the tunnel pit. The remainder of the charge, 2 500 lb. of powder, was then placed in the pit and on top of the dynamite primer.

The wiring consisted of 20-ft. double-strength electric fuses, from each of the three primers of dynamite to the main tunnel, where they were connected in series to the battery at the portal. The wire connections between the primers were: a No. 16 B. & S. gauge, insulated copper wire from the battery to the pit *X* 60% primer, thence to the pit *X* 40% primer; a No. 24, insulated copper wire from this latter to the pit *Y* primer, and thence a No. 16 wire back to the battery. The wires were covered with 6 in. of fine earth, and were protected further at the drift portal by being enclosed in a grooved board laid across the portal and covered with earth. The resistance of the circuit at the tunnel portal was 8 ohms, by a Dupont galvanometer.

The first tamping used was fine earth, well tamped on the powder, and completely filling both tunnel and drift for a distance of 10 ft. back from the charges. Bulkheads of rock were placed at intervals of 10 ft. throughout the length of the tunnel in order to tamp its roof solidly. At the drift portal and locking against the opposite wall of the tunnel, a bulkhead of heavy green oak timbers was placed and well tamped. The earth and rock tamping was then carried forward to within 20 ft. of the tunnel portal. If the ground had been conglomerate instead of exceedingly hard granite, the total weight of dynamite

PLATE CLIII.
PAPERS, AM. SOC. C. E.
OCTOBER, 1911.
O'SHAUGHNESSY ON
MORENA ROCK FILL DAM.


19' 6" Dia.
Elevation 155.5 Ft.
Elevation of Water 151 Ft.
Elevation 131 Ft
Angle Iron Flange rivet on in Field Rivet Holes in Pipe drilled to suit Holes in Flange
Outlet No.5 Elevation 127.5 Ft. 10.1 lb.
Holes drilled in Pipe to suit Flange Cast-Iron Flange in Place
Elevation 103 Ft
Cast-Iron Flange-Rivet on in Field Rivet Holes drilled in Pipe to suit holes in Flange
Outlet No.4 Elevation 99.5 Ft. 22.2 lb.
Holes straddle these center lines
Position of Bolts same in these 3 Flanges
Outlet No.3 Elevation 71.5 Ft. 31.2 lb.
Holes straddle these center lines
Grating 24" wide Supported by 2-8" x 18-lb. I Beams
Elevation 17 Ft
Position of Bolts same in these 4 Flanges
Outlet No.2 Elevation 43.5 Ft.
Outlet No.1 Elevation 33.5 Ft.
Elevation 1 Ft
24" Manhole cover removed
Bronze Bolts in wall
15' 0"
Recess in Support to allow for Joint
1¼" Bronze Bolt
1" x 6" Steel Support
These Flanges to be supplied with 1" bolts-nut each end
Holes for Strap Bolts for bolting down grating
1¼" Bronze Bolts
Support for 30" Pipes
Angle Iron Flanges
Steel Pipe
Lead Joint
24" Steel Pipe
Cast-Iron Flange
Core for 6-1⅛" Bolts
All 30" Pipe Flanges drilled for 28-1⅛" Bolts on a 38" Bolt Circle
All 24" Pipe Flanges drilled for 20-1⅛" Bolts on 29½" Bolt Circle
Drill 20-1⅛" Holes for 1" Bolts on a 29½" Cir
Center Bar Steps
Steel Taper Bars
Rods ¾" Nut both Ends
Steel Taper Bars ⅝" x ⅜" x 3"
⅝" Rod Nut both Ends
2" Dia. C. I. Distance Piece
Handles cast on
Cut Smooth
Core for 1¼" Bolts
28'

VERTICAL SECTION ALONG CENTER LINE OF OUTLETS

HORIZONTAL SECTION OF TOWER ON LINE *A.A.*
Gate No.5

HORIZONTAL SECTION OF TOWER ON LINE *B.B.*
Gate No.4

HORIZONTAL SECTION OF TOWER ON LINE *C.C.*

PLAN OF BASE OF TOWER FROM HORIZONTAL SECTION ON LINE *D.D.*

CAST-IRON BASE ELBOW

CAST-IRON 30" X 30" X 24" TEE

CAST-IRON 24" TEE

CAST-IRON WALL PIECES
2'0" for Gate No 5
3'1" for Gate No 4
4'5" for Gate No 3
3'0" for Gates No 2 and 1

CAST-IRON BEND FOR OUTLET NO. 3

CAST-IRON BEND FOR OUTLET NO. 4

CAST-IRON BEND FOR OUTLET NO. 3

CAST-IRON BEND FOR OUTLETS NOS. 1 AND 2

DETAIL OF GRATING FOR OUTLET VALVES

DETAIL OF GRATING FOR MUD GATE

CAST-IRON MANHOLE CASTINGS

CAST-IRON SCREEN HANGERS

OUTLET TOWER-MORENA DAM
SAN DIEGO CO.
FOR
SOUTHERN CALIFORNIA MOUNTAIN WATER COMPANY

primers used would have been 500 lb. instead of 5 400 lb., for in conglomerate the percussive action of dynamite would be waste energy, inasmuch as the action required would be heaving, and the sole use of dynamite in the charge would be to control the rate of detonation of the nitro-glycerine content of the "Champion" powder. In the hard granite at Morena a rending as well as a heaving action was required, in order to produce adequate results, hence the use of a comparatively large quantity of dynamite.

During the loading and handling of the large quantities of powder, it was customary to require that all the men thus engaged surrender matches and smoking materials, and that the men in the pit remove their shoes and wrap their feet in sacking. The circuit was tested frequently at the tunnel portal during tamping in order that possible breaks be detected and repaired before burying the wires too deeply. The battery was tested up to full strength before using. Light was furnished by candle lanterns securely wired to pegs driven into bore holes in the sides of the tunnel and drifts.

The loading of the charge was surpervised by Mr. J. S. Molony, Resident Engineer, and Messrs. A. H. Crane and H. F. Smith, Agents for the Dupont Powder Company.

On August 30th, 1909, the blast was exploded electrically, and the result was most satisfactory, as it displaced about 180 000 tons of rock at the moderate price stated. The greater part of the whole mass of granite was broken into blocks of from 50 lb. to ¼ ton in weight. The fact that about 75% of the pieces weighed less than 10 tons enabled the cables to do very effective work with little plugging.

Outlet Tower.—Through the solid bed-rock on the south side of the dam at the 30-ft. contour, a tunnel, 387 ft. long, 8 ft. wide, and 7½ ft. high, was drifted, through which the water from the reservoir is drawn off. This is done through a reinforced concrete tower, Plate CLIII, 15 ft. 6 in. in external diameter, with walls varying in thickness from 3 ft. 0 in. to 20 in. At the top of this tower, at an elevation of 155½ ft., there is an operating deck of reinforced concrete from which the outer gates are regulated. These gates are of the Coffin Valve Company's sluice type with vertical stems controlled by guides let into the concrete. Around each gate there is a screen to keep trash and drift from entering the 24-in. circular, cast-iron pipes passing through the walls of the tower and connecting with a 30-in. vertical down-pipe which discharges into the tunnel. These outlets are 28 ft. apart vertically, so that the water may be drawn off under a light head from any of these levels. Between each opening and the down-pipe there is a curved, removable, bolted, flanged casting to enable the gates to be easily removed, if it is ever found necessary. Each is attached to Crane gates which are operated from platforms inside the tower at the different levels, and are used for emergency purposes only. The admission of water through the outer sluice-valves relieves the leaf-valves from any chattering effect developed by the spouting water which discharges into the down-pipe and flows freely through the tunnel. There is also an independent 24-in. cast-iron pipe which will be used for washing out the sediment which, in the future, may accumulate near the base of the outlet tower. This pipe passes through the foundation of the tower and is connected with the tunnel. The inner 75 ft. of the tunnel—in solid granite—is lined with concrete; it is connected with the base of the tower, and encloses the pipes which discharge at the floor of the tunnel, so that every precaution has been taken to obtain, at a moderate expense, as simple and safe an outlet as possible. From the outer end of the tunnel the water will be permitted to flow at present along the natural grade of Cottonwood Creek until it is picked up above the Barrett Dam site by the Dulzura Conduit.

The work has been done by day's labor under the supervision of Mr. J. S. Molony, acting as Resident Engineer and General Superintendent, with Messrs. R. Wueste and R. P. McIntosh as Assistants. About 95 men have been constantly employed since the blast explosion of August 30th, 1909, and the work has been peculiarly free from accidents, owing to the careful and conscientious supervision exercised by the men in charge.

The face masonry and back-filling have been expensive, the average cost of the whole work having been $2.50 per cu. yd., but the actual placing of the rock in the dam from the quarries has not cost more than $1 per cu. yd. The whole plant had to be rehabilitated on resuming work in 1909, which, of course, has added slightly to the unit costs, though labor conditions at present in that part of California have made work cost about 30% in excess of prices twelve years ago.

The writer has acted as Chief Engineer and Consulting Engineer of the project, and has not been restrained in any way by the President of the Company, Mr. Spreckels, who practically owns the entire water system, from modifying the plan of operations or type of construction to suit conditions as the work progressed.

As San Diego is growing rapidly, having a population of 45 000 at the present time, every precaution is taken by the Southern California Mountain Water Company to conserve a sufficient supply of water to take care of the increased population and growth which the Panama Canal and other factors are bound to create.

Vol. XXXVII. OCTOBER, 1911. No. 8.

AMERICAN SOCIETY OF CIVIL ENGINEERS

INSTITUTED 1852

PAPERS AND DISCUSSIONS

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THE HALLIGAN DAM: A REINFORCED MASONRY STRUCTURE.

By G. N. Houston, M. Am. Soc. C. E.

To be Presented December 20th, 1911.

The Halligan Dam is on the North Branch of the Cache La Poudre River, about 12 miles above the Town of Livermore, 35 miles northwest of Ft. Collins, Colo., and 16 miles from the nearest railroad siding. It impounds the water of that stream in a reservoir having a capacity of 6 408 acre-ft., being one of sixteen which, with their connecting canals, form the Irrigation System owned by the North Poudre Irrigation Company, of Ft. Collins. This is a stock company capitalized for $400 000, practically all the stock being held by the owners of the land on which the water is used.

Before the writer was retained as Consulting Engineer, plans had been prepared for an arched cyclopean masonry dam, with a gravity section, to store water to a depth of 55.5 ft. above the outlet tube, and a contract had been let for its construction at cost plus 20 per cent. Work was commenced, but, after building to a point slightly above the lower outlet tube, the available funds were exhausted and the work was temporarily abandoned. The foundations remained in

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Note.—These papers are issued before the date set for presentation and discussion. Correspondence is invited from those who cannot be present at the meeting, and may be sent by mail to the Secretary. Discussion, either oral or written, will be published in a subsequent number of *Proceedings*, and, when finally closed, the papers, with discussion in full, will be published in *Transactions*.

In the *Proceedings* of this Society, the Papers and the Discussions on Papers will hereafter be printed so that each will commence on an odd-numbered page. This is done by special request, in order to enable members who wish to do so to separate the Papers and Discussions for filing under various engineering subjects.

this condition for about 18 months, and then the work was resumed under the writer.

The problem was to obtain as much storage capacity as possible for a limited sum of money, and the question then became how far to depart from established precedent in order to meet the economic conditions. There was the gravity section, built in the form of the arch, as the ultra conservative type, and the Bear Valley Dam as the extreme in the other direction. The writer's design is submitted as one which best fulfills the requirements, and one in which the stresses can be demonstrated to be safe.

New plans and specifications were prepared for a cyclopean masonry dam, reinforced with steel rods, to be built on the foundations already constructed. This dam is of lighter cross-section than the original gravity type designed, and 14.3 ft. higher.

This additional height increased the storage capacity by at least 2 500 acre-ft., which, at the usual price of $40 per acre-foot, is worth $100 000. A conservative estimate shows that the dam was built at a cost of $7 000 less than if it had been constructed according to the original plan. In other words, the company saved $107 000 by the use of this design instead of the usual gravity section.

There are about 3 500 cu. yd. of masonry in the old work, and 12 134 cu. yd. in the new structure, making a total of about 15 634 cu. yd. in the whole dam. The cost of the old work was more than $100 000, that of the new work was about $80 000. Work was begun under the writer's supervision in July, 1909, and completed on May 1st, 1910.

Construction.—The foundations, as left by the first contractor, were very uneven, and, before beginning the new structure, it was necessary to use about 1 400 cu. yd. of masonry to bring them up to the elevation of zero, as shown by Fig. 1.

For 35 ft. above this point the dam was constructed of cyclopean masonry, consisting of large, irregular masses of rock, varying in size from 1 cu. ft. to 2 cu. yd., bedded in a 1:3:5 concrete, mixed wet. Smaller rocks were used to fill in between the large masses, 6 in. being the minimum distance between the stones. The quantity of cement used in the concrete for this part of the work was about 1.20 bbl. per cu. yd. The rock content averaged 27% of the total mass.

After the construction had reached approximately Elevation 35,

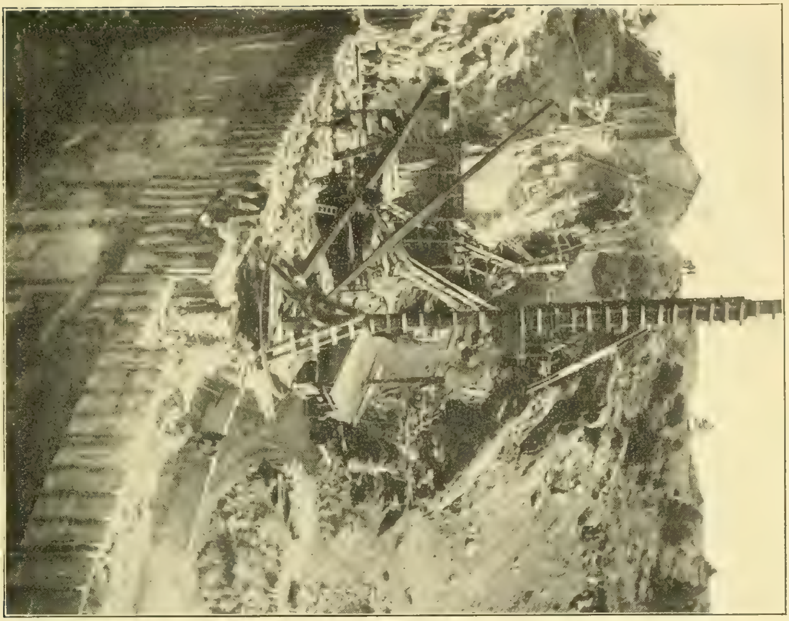


FIG. 1.—UP-STREAM FACE, DURING CONSTRUCTION.

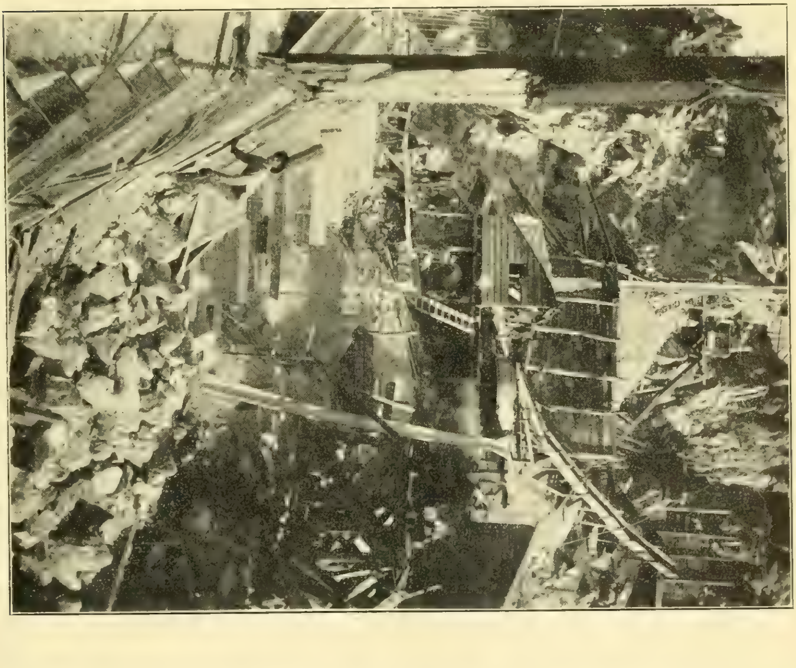


FIG. 2.—DOWN-STREAM FACE, DURING CONSTRUCTION.

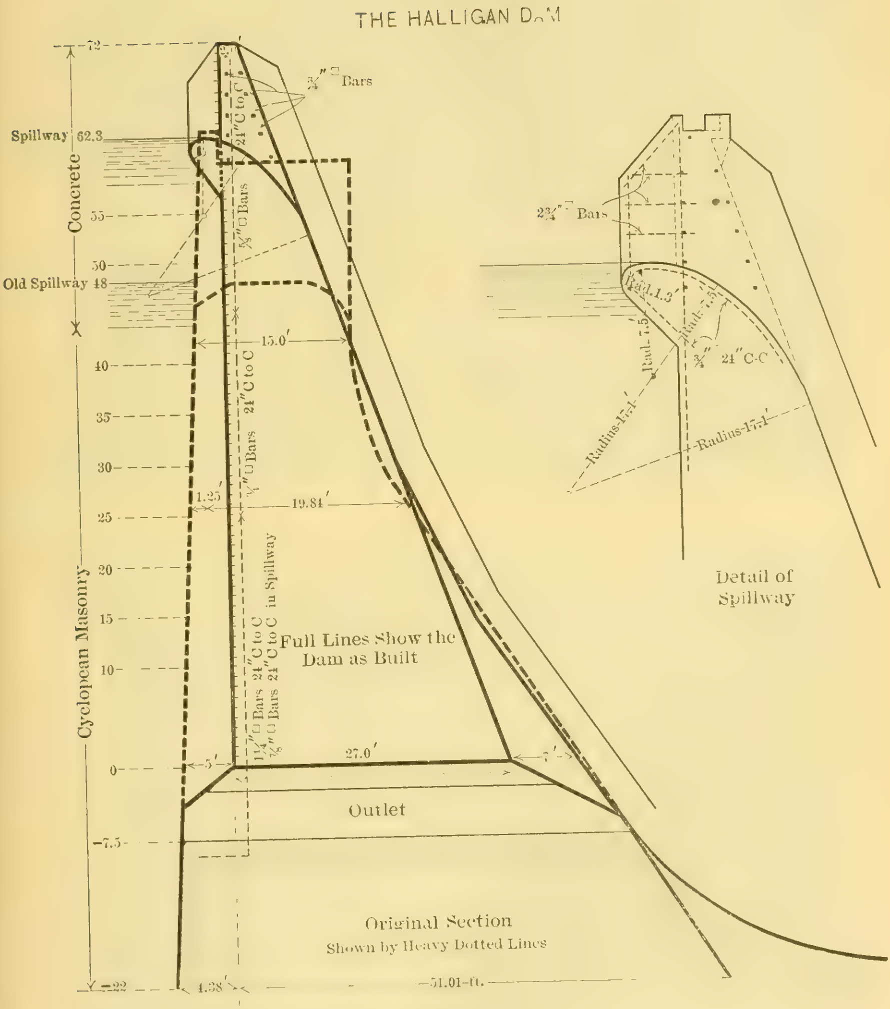

THE HALLIGAN DAM
72
¾" □ Bars
21" C to C
Spillway 62.3
Concrete
55
⅝" □ Bars
50
Old Spillway 48
15.0′
21" C to C
40
35
¼" □ Bars
30
1.25
19.84′
25
20
15
10
Cyclopean Masonry
1¼" □ Bars 21" C to C
⅞" □ Bars 21" C to C in Spillway
Full Lines Show the Dam as Built
0
5′
27.0′
7′
Outlet
−7.5
Original Section
Shown by Heavy Dotted Lines
−22
4.38′
51.01 ft.
2¾" □ Bars
Rad. 1.3′
Rad. 7.5′
Rad. 7.5
¾" 21" C-C
Radius 17.1′
Radius 17.1′
Detail of Spillway

Fig. 1.

the character of the large rock became so poor that it was decided to build the remainder of the dam entirely of 1 : 3 : 6 concrete. The projecting lip of the spillway, however, was built of a mixture of about 1 : 2½ : 4. The crushed rock varied from a small percentage of pieces having a greatest dimension of 6 in. to pieces ½ in. in diameter. All material finer than ½ in. was excluded on account of the large percentage of mica which it contained. The sand used was very coarse, although it varied somewhat. An average of nine analyses gave the following result :

Size.	Percentage, by weight.
Larger than ¼ in. in diameter, classed as gravel...	8.8%
Passed ¼-in. mesh..............................	91.2%
" No. 20 sieve, 0.034 in. in diameter......	29.2%
" No. 30 " 0.022 " " "	15.2%
" No. 100 " 0.0045 " " "	2.2%

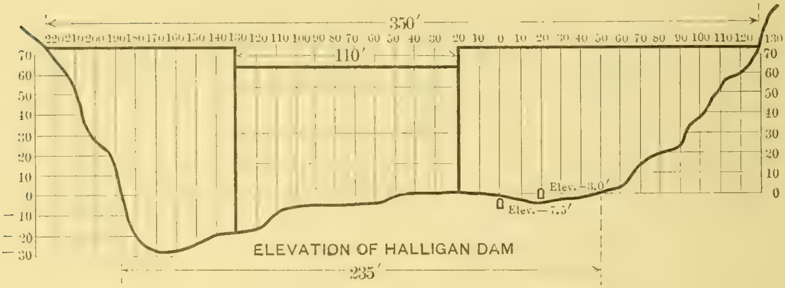


FIG. 2.

All the cement was furnished by the Colorado Portland Cement Company, and, with the exception of about 1 000 bbl., was tested at the George Pierce Testing Laboratories, at Portland, Colo.

TABLE 1.—SUMMARY OF TESTS OF 10 000 BARRELS OF IDEAL PORTLAND CEMENT USED IN THE CONSTRUCTION OF THE HALLIGAN DAM.

	TENSILE STRENGTH.					FINENESS.		TIME OF SETTING.			
	Neat.			One to three.		Passed 100 mesh.	Passed 200 mesh.	Initial set.		Final set.	
	1 day.	7 days.	28 days.	7 days.	28 days.			H.	Min.	H.	Min.
Maximum.....	480	945	970	415	490	98.8%	87.7%	5	20	9	55
Minimum.....	150	625	700	235	315	94.0%	74.2%	2	15	3	55
Average.......	311	706	828	327	400	96.3%	79.2%	4	0	6	36

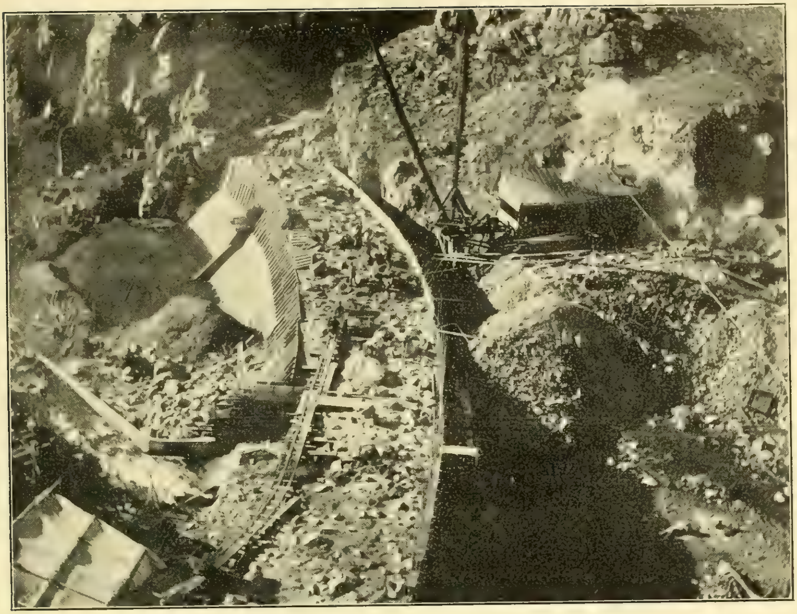


FIG. 1.—VIEW FROM ABOVE, DURING CONSTRUCTION.

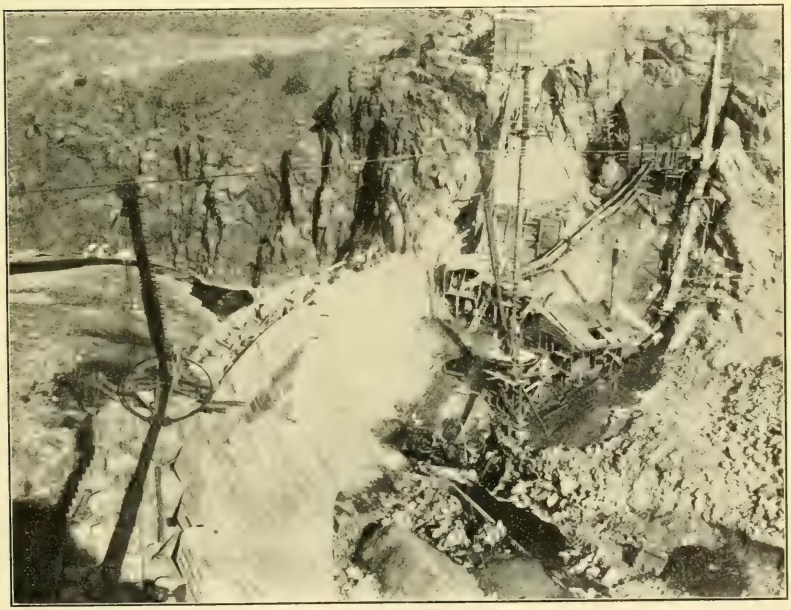


FIG. 2.—VIEW FROM ABOVE, DURING CONSTRUCTION.

Concrete was laid during the day through all but the severest winter weather. The water was heated, and varied in temperature from 130 to 160° Fahr. An attempt was made to heat the sand, but was abandoned as not necessary. The temperature of the concrete as deposited in the dam varied from 35 to 60° Fahr. Before bedding the large rocks they were cleaned with a jet of steam. During the night the new work was covered with tarpaulins, under which lighted lanterns were placed. Concrete was not mixed when the temperature was lower than 20° Fahr.

The bulk of the reinforcement was of high-carbon steel. Two samples of this steel were tested at the Laboratories of the University of Colorado, and showed an elastic limit of 50 000 and 59 000 lb. per sq. in., respectively. A small quantity of twisted steel was also used in the upper part of the dam. Where the elevation of the old foundation was — 3, or lower, the reinforcement was bent, as shown on Fig. 1, and built into the work. Where the foundations were higher than this, holes 1 in. larger in diameter than the bars were drilled from 3 to 5 ft. deep and the bars were set in neat cement grout.

The dam presents two novel features: The projecting spillway, and the light cross-section of both the main dam and spillway.

Spillway.—The writer originally contemplated a spillway wholly within the cross-section of the dam, but his attention was called to the fact that a discharge over it having a depth of from 2 to 3 ft. would probably leave the face of the dam. As there was a possibility of discharges of much greater depth, it was necessary to widen the crest of the spillway in some way, hence the projecting lip. The surface of the spillway is a compound curve, formed by the arcs of three circles, and following as nearly as possible the curve of discharge of an 8-ft. head of water over a sharp-edged weir, as determined by Bazin's experiments. Reinforcement was placed in the lip, as shown by Fig. 1, and needs no special comment. The capacity of the spillway is about 14 000 sec-ft., and that of the two outlet tubes is about 1 400 sec-ft.

Stresses.—The following analysis of the stresses in the dam is based on the following assumptions:

First: That the high-water level is 9.7 ft. above the spillway, that is, to the top of the dam.

Second: That the dam resists the water pressure partly as a cantilever beam and partly as an arch.

Third: That the center of gravity of the compressive forces is at a point distant from the down-stream face 0.15 of the effective thickness of the dam.

Fourth: That the dam section is a complete triangle, thus making the perpendicular line through the center of gravity of the section cut the base at a point one-third the thickness of the dam from the rear face.

Fifth: That the safe load (tension) on the reinforcement is 12 000 lb. per sq. in.

Sixth: That the neutral axis of dam, considered as a beam, is at a point 0.4 the effective thickness from the down-stream face.

Seventh: That the thrust in the arch is uniformly distributed over the thickness of the dam.

The general method used is to assume the safe load on the reinforcement, find what part of the water pressure can be safely carried by the dam considered as a beam, and then assume that the arch carries the remainder of the pressure.

In the following equations the various functions are represented by the following letters:

P = Total overturning pressure on the dam, in tons;

P'' = That part of P assumed to be sustained by the beam action, in tons;

P' = That part of P assumed to be sustained by the arch action, in tons;

w = Weight of 1 cu. ft. of water, in pounds;

r = Radius of curvature of dam, in feet, = 324;

j = Thickness of the dam at any point, in feet;

h = Height of the dam at any point, in feet;

W = Weight of masonry in the dam above any point, in tons;

T = Thrust in arch due to P', in tons per square foot;

y = Assumed stress in steel, in tons;

c = Maximum compression in the outer face of the dam due to beam action alone, in tons per square foot;

z = Total compressive stress in dam due to beam action alone, in tons;

PLATE CLVI.
PAPERS, AM. SOC. C. E.
OCTOBER, 1911.
HOUSTON ON
THE HALLIGAN DAM.

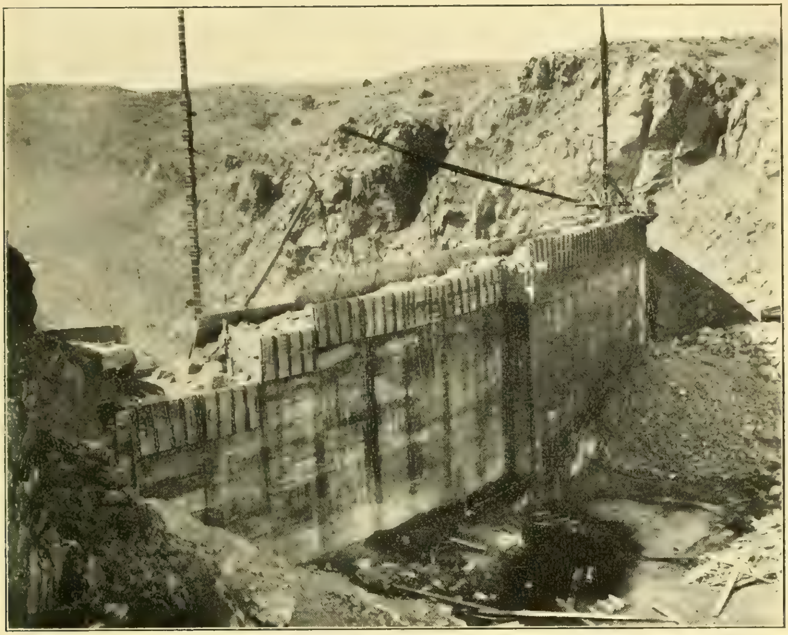


FIG. 1.—CONCRETE FORMS IN PLACE.

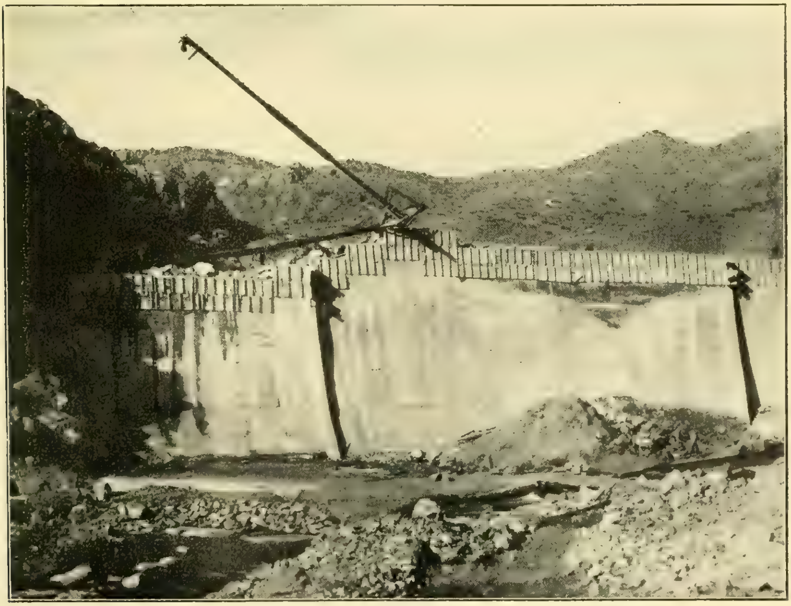


FIG. 2.—DOWN-STREAM FACE, SHOWING SPILLWAY.

q = That part of the pressure at any point sustained by arch action alone, in tons.

Fig. 3 is a diagram of the stresses acting on the dam.

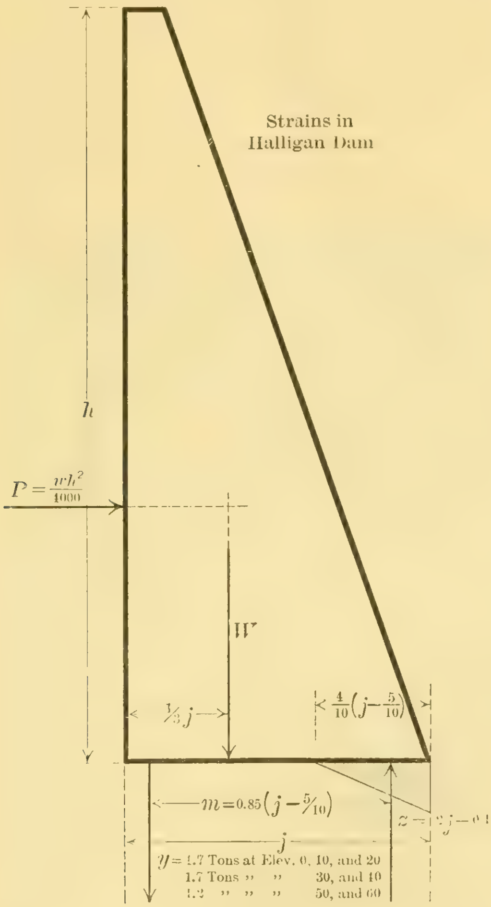


Fig. 3.

At Elevations 0, 10, and 20; $y = 4.7$ tons,
" " 30, and 40; $y = 1.7$ tons,
" " 50, and 60; $y = 1.2$ tons.

$$m = 0.85\ (j - 0.5)$$

$$P = \frac{wh^2}{4\,000}$$

Expressing moments around the center of gravity of compression forces, we get,

$$\frac{1}{3} P'' h - W \left(m + 0.5 - \frac{1}{3} j\right) - y\, m = 0$$

Solve for P''.

Then

$$P' = P - P''$$

$$q = \frac{2P'}{h}$$

$$T = \frac{q\, r}{j}$$

To determine c, take moments around y:

$$\frac{1}{3} P'' h + W \left(\frac{1}{3} j - 0.5\right) - c\,(0.2\, j - 0.1)\, m = 0$$

Solve for c.

The stresses obtained by this method are shown in Table 2.

TABLE 2.—SUMMARY OF STRESSES.

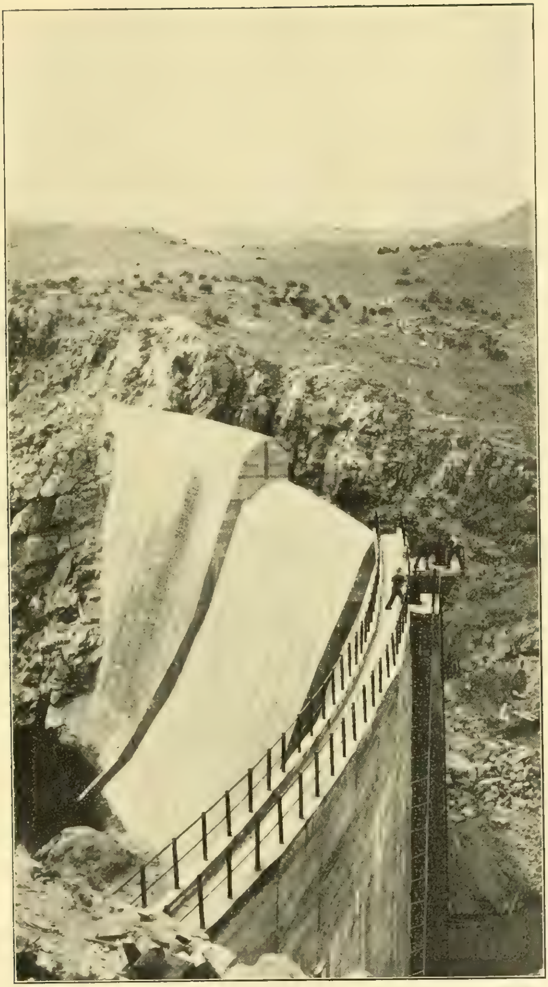
Elevation.	Tension in steel, in tons per square inch.	Thrust in arch, in tons per square foot. *T.*	Compression due to beam action alone, in tons per square foot. *c.*
62.3 Spillway	0.0	0.0	....
60	0.0	0.0	....
50 Calculated	4.5	0.0	5.8
40 Assumed	6.0	4.4	8.0
30 "	6.0	7.2	9.7
20 "	6.0	7.5	12.3
10 "	6.0	9.3	13.5
[illegible]0 "	6.0	10.5	15.7
[illegible]0 "	10.0	9.1	16.3

The factor of safety is about 6.

Fig. 4 is a diagram comparing the Halligan Dam with several others which are well known.

The writer wishes to acknowledge his indebtedness to Charles W. Comstock, M. Am. Soc. C. E., State Engineer of Colorado, for valuable suggestions given during the design and construction of this dam.

PLATE CLVII.
PAPERS, AM. SOC. C. E.
OCTOBER, 1911.
HOUSTON ON
THE HALLIGAN DAM.



THE COMPLETED DAM.

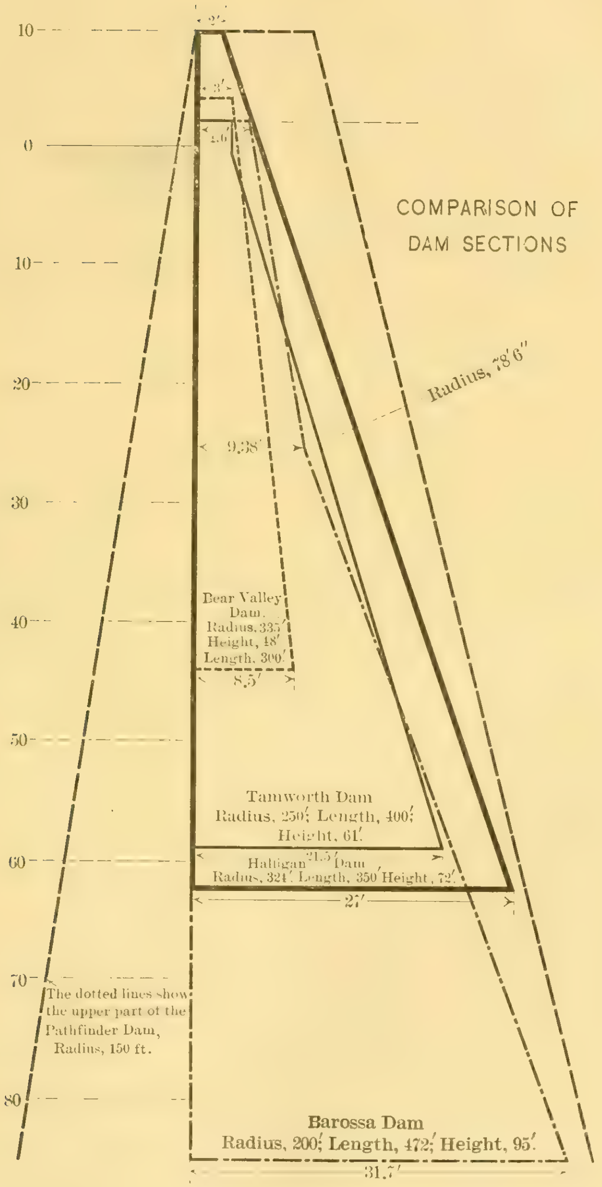

COMPARISON OF DAM SECTIONS
10
0
10
20
30
40
50
60
70
80
2'
3'
4.6'
9.38'
Radius, 78'6"
Bear Valley Dam.
Radius, 335'
Height, 48'
Length, 300'
8.5'
Tamworth Dam
Radius, 250'; Length, 400';
Height, 61'.
21.5'
Halligan Dam
Radius, 324', Length, 350' Height, 72'.
27'
The dotted lines show the upper part of the Pathfinder Dam,
Radius, 150 ft.
Barossa Dam
Radius, 200'; Length, 472'; Height, 95'.
31.7'

FIG. 4.

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AMERICAN SOCIETY OF CIVIL ENGINEERS
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PAPERS AND DISCUSSIONS

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MULE-BACK RECONNAISSANCES.

Discussion.*

By Messrs. George D. Snyder, Ernest McCullough, and F. Lavis.

George D. Snyder, M. Am. Soc. C. E. (by letter).—This paper is of value in calling attention to methods of reconnaissance and mapping which are too little known. Although there is very little civil engineering literature on this subject, it is treated quite exhaustively in works on military topography and sketching. The art of hasty mapping has reached a high state of development by army officers, because, under the necessities of a campaign, it is of more importance to have a map which indicates every road, path, and trail, even if it has errors in distances of from 5 to 10%, than one which has no perceptible errors, but is not up to date and does not show every road. Mr. Snyder.

In common with all mapping, such work is divided into methods of measuring distance, direction, and elevation. The aneroid barometer for elevation and the compass for direction are used almost invariably, but there is a great variety of methods of measuring distance: by timing a horse or mule, after obtaining his rate, as described in this paper; by counting the topographer's paces, or by using a pedometer or passometer; or, where a wheeled vehicle can be used, by counting the revolutions, or using a cyclometer, or odometer; or, on the water, by the use of a patent log, or by counting the revolutions of the screw or wheel; and very accurate results can be obtained with a bicycle.

It is not always the case that where roads exist suitable maps can be had, and, even where accurate maps are available, there is often

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* This discussion (of the paper by William J. Millard, Jun. Am. Soc. C. E., published in *Proceedings* for May, 1911, and presented at the meeting of September 21st, 1911), is printed in *Proceedings* in order that the views expressed may be brought before all members for further discussion.

In the *Proceedings* of this Society, the Papers and the Discussions on Papers will hereafter be printed so that each will commence on an odd-numbered page. This is done by special request, in order to enable members who wish to do so to separate the Papers and Discussions for filing under various engineering subjects.

Mr. Snyder. lacking special information which is necessary to the object of the reconnaissance and can be added by methods similar to those described.

Mr. Millard's method is to record his observations in a notebook and from them prepare a map. What is perhaps a preferable method under most conditions, and will save some time, is to use one of the several forms of sketching cases now on the market, which are nothing more or less than hand plane-tables with a compass for orientation. These devices enable one to plot the route traversed and sketch the topographical features directly on the map, thus saving time and avoiding errors which would not be obvious in a notebook, but are apparent if placed on a map. It is surprising how quickly and accurately an area can be mapped by such methods; and the value of such a rough map, as a preliminary to more accurate surveys, is great, for, as stated by Mr. Millard, it may often furnish information which will indicate that more accurate and expensive surveys are not warranted.

A reconnaissance is made for most engineering projects, and notes of the region traversed are taken in a more or less disjointed manner. Instead of this, a skillful man, in practically the same time, can obtain a map indicating the controlling topographical features, with distances to within 5%, and other notes of value bearing on the project in hand.

Mr. McCullough. ERNEST McCULLOUGH, M. AM. SOC. C. E. (by letter).—As Mr. Millard states that he had never heard of a mule being used for reconnaissance work, the writer would like to add a note of historical interest. During the winter of 1889-90 the writer was employed to make a large topographical map of a number of mines and mining claims in California. The engineer who made the survey, and who had been employed for several months on the work, having lamed his right hand, turned the notes over to him.

The work involved the running of a closed traverse to tie in the claim corners and all the more important features. When this had been done, a "filling-in" survey was made, in order to supply the topographical data, using a mule. A saddle with a high pommel had attached to it a cheap clock and a compass hung in gimbals. A sheet of paper, properly ruled, was fastened to a board strapped to the left arm, and an aneroid barometer was hung by a strap over the shoulder. The mule walked along the trails, and at 15-min. intervals the time was read and also the bearing of the compass and the height as indicated by the aneroid. The sheet of paper was ruled horizontally into 15-min. intervals and vertically into 9 columns, each varying 10 degrees. The compass was graduated from 0 to 360°, and was read only to the nearest degree by the observer, who put down the reading in the column headed by the nearest lower angle. This was done merely for convenience, and the barometer reading was placed on the same horizontal line just ahead.

Mr. McCullough.

Every line was numbered. On the sketching board was placed another sheet of paper, ruled in ten squares to an inch. If the observer thought sketches would help out at any point, he made them on the quadrille-ruled paper, placing on each sketch the number of the line indicating the point at which it had been made. The sketch resembled that shown by Mr. Millard, the same principles being followed. The map was made on a scale of 2 in. to the mile, and the "filling-in" notes closed remarkably. There were many trails through that section, and the mule was ridden over nearly all of them. Vertical angles were taken on the traverse survey, and all elevations were computed from them, so that the aneroid readings were checked whenever possible. In 1890 the writer made a similar survey, and found the method very good for the purpose for which it was used. At that time (22 years ago), it was not considered a new idea, but was thought to be of considerable antiquity.

Mr. Lavis.

F. Lavis, M. Am. Soc. C. E.—This paper is interesting in so far as it describes a method of "filling in" topography which may be quite useful for certain purposes. The idea is by no means new, but the details are described more fully than has been done elsewhere.* If the author had been content to limit its application to this filling in of topography on maps to be drawn to a small scale, the prominent features of which had been controlled by triangulation or other adequate methods, or as a means of locating roughly certain broad general geological features, there would be little criticism possible, but the speaker is of the opinion that its utility, in connection with the location, or any investigation into the feasibility or practicability, of proposed lines of railway, is questionable, inasmuch as it is likely to lead to the assumption that certain information has been obtained which in reality has not. If in what follows the speaker offers some criticism, it should be understood to be solely of the author's proposition to apply his methods to railroad reconnaissance and not of the methods themselves. Referring to reconnaissance, the late A. M. Wellington, M. Am. Soc. C. E.,† wrote, more than a quarter of a century ago, as follows:

> "The feeling should always be present in the mind of the engineer that he ought to be somewhere over the edge of the horizon, or on the other side of the valley or ridge, instead of following his nose where he is," and again: "We may *survey* lines, but we must never reconnoitre them. If we do, it is not a reconnaissance."

He insisted again and again that the reconnaissance should be of an area and not of a line, but the true significance of this does not yet seem to be properly appreciated.

The author's conception of the duties of the railroad engineer who is sent to report on the feasibility or otherwise of a proposed line of

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* "Railroad Location Surveys and Estimates," p. 18.

† "The Economic Theory of Railway Location," pp. 835 and 837.

Mr. Lavis. railway, does not seem to be adequate. It is difficult to imagine a man having the broad outlook suggested by Wellington, while counting the steps of a mule. The engineer who is to make such an examination should be one who is not only experienced in the location of railroads, but also in their construction and operation, especially the latter; he should have some knowledge of the methods of financing such propositions; of the information wanted by bankers or financiers, and of how this should be presented to them. He should pay especial attention to the amount and nature of the business which will come to the road, as the kind of road which should be built will depend on this. Such an engineer, as he rides over the country, will pay far more attention to the probable business of the road than to the gait of his mule, or even the distance or direction in which he is traveling. This may seem to be rank heresy to those who have thought of the pioneer railroad engineer, with his barometer and compass, as the legitimate successor of the great explorers in opening up undiscovered countries, but, prosaic as it is, it is a fact.

Many engineers and contractors of sufficient experience can, by riding over a route, make a fairly close estimate of the probable cost, that is, the grading and bridging. Contrary to Mr. Millard's ideas, however, they are not "trained to measure cuts and fills, estimate the cost of bridges, and judge as to curvature, etc.," by eye. They very carefully refrain from going into details of this nature without a survey, but, as the result of long experience on many lines in different kinds of country, they can estimate in round figures how much per mile certain lines or sections of lines will run for the grading and bridging; and, as this represents usually only about 50% or less of the total cost of the complete line with equipment, the other 50% being for items, the cost of which can be determined quite accurately with little reference to topographical conditions, any variation in the total cost is usually well within the allowable limits for preliminary estimates.

It is usually necessary, however, in addition to an estimate of the cost, that the engineer should know fairly closely the length of the proposed line and have some adequate idea of its physical characteristics, that is, the approximate ruling grade, amount of rise and fall, and amount and character of curvature, the first being the most important and most difficult to estimate.

The fact that Wellington and other writers have stated that it is possible for the experienced locator to eliminate certain manifestly impossible routes simply by looking them over, has been misinterpreted quite generally, and there seems to be a feeling that, by some occult means, a close approximation of these physical characteristics may or should be made without going to the cost and trouble of making an instrumental survey. Where topographical maps, equal to those

Mr. Lavis.

of the United States Geological Survey, are available, this may be done by projecting the proposed lines on these maps; failing this, there is, in the speaker's opinion, no recourse except in some cases in easy country, and even then it is well to be very careful, and to make, at the very least, a rough skeleton stadia survey.

In a former discussion on this subject, S. Whinery, M. Am. Soc. C. E.,* referred to: The Genius * * * who, disdaining plats [and presumably transits, levels, etc.], takes in at a glance the P. C., and the degree of a curve that will fit the hill comfortably, and, at the proper point on that curve, sails off on a tangent that will strike the bull's eye 2 miles away. Such geniuses, however, are apparently and fortunately all gone, and the genius nowadays, who is not nearly as spectacular, spends his time, in his tent at night, wiggling a piece of black thread back and forth on his map, figuring how he can do away with the curve and not spend any more money, and he generally does it.

The author evidently recognizes the difficulty of guessing by eye at either the length of line or the rate of grade in such country as that between San Felipe and Quezaltenango in the "Altos" of Guatemala, which can only be described as being "all on end" and "up in the air." He is mistaken, however, in assuming that there is, or at least should be, any excuse for guessing at all in such country. It is not necessary to make a geodetic survey for any purpose whatever in connection with railroad location, but the engineer who is asked to make a reconnaissance in such country—or in any other where it is necessary to supplement the "eye" of an ordinarily well-trained engineer—should either insist on sufficient assistance and time for an adequate survey or refuse to give his opinion.

The author states that two men are necessary to carry out properly the methods described by him, and that they average about 15 miles a day in rough country. Two good men and a native with a stadia can cover from 5 to 7 miles, and they would obtain information which would be of real value. The survey may be ever so rough and sketchy, but it does give actual distances and elevations correctly within the requirements of the case.

Despite all that has been written as to their value, the speaker regards the aneroid and the compass, for use in connection with railroad reconnaissance, as little better than toys. It is seldom that the railroad engineer has any opportunity to compare aneroid readings with those of a mercurial barometer at a base station, and here again, with instruments delicate enough to give sufficiently close readings, assistants to read them, and methods of obtaining distances and directions sufficiently accurate to determine, even approximately, the possible rate of grade on a long supported line. The expense incurred

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* *Transactions*, Am. Soc. C. E., Vol. LIV p. 143.

Mr. Lavis. and the time consumed in such observations would be very little, if any, less than would be required to run a rough stadia line which would give so much more and better information of the kind wanted by the railroad engineer.

The only information which is of use to him, in order that he may determine the physical characteristics of a line, even approximately, must give distance, elevation, and direction with a fair degree of accuracy. It is the speaker's opinion that the methods proposed by the author will not do this. A precise survey is not necessary, but a stadia survey, intelligently made, will give the information, and its expense will be very little if any greater than would be incurred in carrying out the methods proposed.

One cannot doubt the author's statement that he closed a traverse of 81 miles in the extremely rough country referred to, within $\frac{3}{8}$ mile, by estimating the rate the mule walked and reading the compass to the nearest 5°, though this would almost be a fair check for a rough stadia line, and great credit should be given to the intelligent mule who was such a capable and useful member of the party.

The speaker thinks that the picture of tropical America drawn by the author is more impressionistic than real. He says:

> "The railroad or mining engineer who is sent to the tropics * * * disembarks from the steamer at a little port, and is there confronted by the wilderness."

The reader's imagination will picture the whole of America, from the United States to Buenos Aires as a wilderness of tropical vegetation, dotted here and there along the coast by "little ports" with a few thatched huts and cocoanut palms. He may forget that Havana, Vera Cruz, Panama, Cartagena, Rio de Janeiro, Lima, and a dozen other cities are ports of the tropics, and that in the interior there are a number of important and interesting cities, many of whose inhabitants are educated and cultured people.

The entrances to Guatemala, it is true, are not particularly impressive, but they are all connected by railroads with the interior, and three of the four ports are connected by rail with the Capital. From Puerto Barrios, on the Atlantic side, there is an excellent line of railway, with track fairly well ballasted, steel bridges, and modern rolling stock, running to Guatemala City, where connection is made with a line running to San José and Champerico, ports on the Pacific coast, and which very shortly will be connected with the National Railways of Mexico, giving all-rail communication with New York. From the Atlantic coast, the journey to the Capital may be made in reasonable time in a comfortable chair car with an observation platform. Leaving Puerto Barrios, instead of a wilderness, the line passes for 60 miles through banana plantations, from which nearly 1 000 000 bunches will probably be shipped to the United States this year. Beyond Guatemala

Mr. Lavis.

City, the Pacific slope is covered with coffee and sugar plantations, the coffee production alone amounting to some 40 000 tons per annum, valued at not less than $8 000 000 in gold.

Next below Guatemala is Salvador, with a population of more than 1 000 000, on an area of about 7 800 sq. miles, averaging nearly three times as many per square mile as in the United States. One may ride for days and see little land that is not under cultivation, and it is probable that, in a few years, the existing lines of railway will be connected with each other and with the railways of Guatemala, and so with Mexico and the United States.

There are many large areas in the United States itself which will not compare particularly favorably, either in exploitation of natural resources or in the culture and hospitality of the inhabitants, with many of these countries. What has been noted in regard to Guatemala and Salvador will apply in greater or less degree—and on the whole it will be greater rather than less—to all the other countries of tropical America, and it is hardly fair, even unintentionally, as was no doubt the case in this instance, to convey the impression that Latin America is a wilderness, waiting for the exploring engineer and his mule.

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AMERICAN SOCIETY OF CIVIL ENGINEERS

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PAPERS AND DISCUSSIONS

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ECONOMIC CANAL LOCATION IN UNIFORM COUNTRIES.

Discussion.*

By Messrs. H. J. Doolittle and C. E. Shipman.

H. J. Doolittle, Assoc. M. Am. Soc. C. E. (by letter).—After having spent some six years on railroad location work, and about two years on canal location with the United States Reclamation Service, the writer is very much interested in the methods described in this paper, and quite agrees with them in general. In some instances he has adopted slightly different methods, which are presented herewith. Mr. Doolittle.

Before going into the field, tables of semi-tangent lengths, tangent offsets, external secants, normal cuts, and excavation quantities, were prepared. The organization of the party was the same as described by Mr. Bishop, except that a back-flagman and only one stakeman were employed. The tables were distributed as follows:

To the chief of party, the tables of normal cuts and quantities;
To the transitman, the tangent offsets;
To the head chainman, the semi-tangent lengths, curve lengths, and externals.

As chief of party, the writer carried a level rod, clinometer, signal cloth, and a piece of profile paper for the purpose of carrying grade elevations.

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* This discussion (of the paper by Lyman E. Bishop, Jun. Am. Soc. C. E., published in *Proceedings* for August, 1911, and presented at the meeting of September 21st, 1911), is printed in *Proceedings* in order that the views expressed may be brought before all members for further discussion.

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Mr. Doolittle.

By the use of the level rod and clinometer, the slope was obtained, and, from the table of normal cuts, the desired normal cut, which, added to the grade elevation, gave the elevation of the desired ground surface. The rod reading was then calculated, the elevation of the levelman's H. I. being known, the target was set, and then the levelman was signaled to set the writer on grade. This point was witnessed by a piece of signal cloth.

In the writer's judgment, these grade points should be set by the chief of party, who, while doing so, can best study the ground; and it will only be necessary for him to establish grade at controlling points. The change of grade per station is usually so slight that a variation of 100 ft. in distance is of no consequence, and hence, the distances ahead to grade points can be paced with sufficient accuracy for all practical purposes.

When the central angle will justify it, the writer prefers to run to the P. I., which is established by the chief of party, who, from the tangent ahead, halts the head chainman, as he advances along the back tangent, when he reaches a point which will best fit the tangent that is being established. The transitman then sets up at the P. I., measures the central angle, which, with but a slight change, can often be made either an even degree or an even 10′, thus affording easy use of the tables.

The transitman announces the central angle, and the degree of curvature is selected; this is determined usually either by the desired external secant or the proper semi-tangent length. The head chainman then calls out the semi-tangent length and the curve length from the table, and he and the transitman calculate the P.C. and the P. T., the stations of which are recorded on the witness stakes by the "stake artist." The P. C. is then set, and the first half of the curve is established by tangent offsets. Then the chainmen measure the semi-tangent distance to the P. T. and back in the remainder of the curve, also by the tangent offset method, and the distance between the last two stakes set in opposite directions is checked, and, if found correct, the chaining is resumed from the P. T.; thus, from one set-up, the curve is established in a rapid and practical manner.

When it is impracticable to establish the P. I. on account of the size of the central angle, and when the radius of the maximum allowable curve is less than 100 ft., the following method has been used successfully: Place the rear chainman as near the center of the curve as it is possible at first to locate him. With a little practice he will be able to judge pretty well when he is equidistant from the head chainman who occupies the P. C. and the chief of party who stands at the P. T. The head chainman then holding the proper radius length, the other end of the chain being held by the rear chainman, moves along the curve as a trial, and, if he strikes above or below the desired

Mr. Doolittle.

tangent at the P. T., the rear chainman then takes a new position, so as to bring the head chainman on tangent to the line ahead, the rear chainman at the same time maintaining the proper distance from the preceding tangent. The head chainman then swings back to the corrected P. C. which can be established at an even plus, to facilitate calculating the deflections, which the writer always makes according to the rule that three-tenths of the degree of curvature equals the deflection in minutes per foot. The transitman then moves up to the P. C., and the curve is established by deflections, it being best to hub about half way on the curve.

The P. T. is determined by the following trial method: First, set the head chainman's flag at a point which seems to be the proper P. T., then measure over, from the last stake, the tangent offset distance. These two points give the direction of a tangent ahead. By this method the P. T. is shifted so as to give the desired direction for the tangent ahead, and the transitman again moves up to the P.T., and the work continues.

Mr. Shipman.

C. E. Shipman, Assoc. M. Am. Soc. C. E. (by letter).—This paper furnishes some useful information on a part of irrigation work to which all textbooks, as far as the writer has noticed, give but scant attention. They give lengthy discussions on dams, run-off, headgates, and diversion weirs, subjects which are no doubt of great interest to the Chief Engineer, but when the young engineer wants to find out how to go into the field and actually locate a canal economically, he will find little to aid him in textbooks on irrigation engineering.

This paper is the first the writer has seen on the details of canal location. It brings up a practical question which neither the author nor the textbooks mention, yet it is one which has frequently puzzled the writer, that is, how to handle overhaul. The writer has used practically the same method of location as that described by Mr. Bishop, and has found that in trying to fit a set of curves and tangents to a falling contour defined by flags, it is almost impossible to make the cuts and fills balance exactly. One station may have an excess cut of 30 yd. and the next an excess fill of the same amount. Will the contractor haul that excess cut of 30 yd. from one station to the next? He will not, but will waste in one station and borrow in the other. If the free haul is 300 ft., neither will he pick up 50 yd. of excess excavation in one station and haul it 290 ft. to fill up a hole in the bank of a station that has an excess fill. Neither will he pick up 100 yd. of excess cut in one station and haul it 100 ft. beyond the free-haul limit for 1 cent per yd., which is what he usually gets for overhaul. Yet he is expected to, and is paid for doing just those things. One cent per yard for overhaul may be proper on railroad work where a 100 000-yd. cut is to be hauled ½ mile or so and dumped into a short

Mr. Shipman.

heavy fill, but it is not right for the small hauls usually encountered on canal construction. Neither is it right to expect the contractor to move small yardages for short distances, for he cannot do it economically. It has been argued that this is simply a method of paying the contractor, but it seems absurd to pay him for doing one thing when he actually does something else. On the other hand, if an attempt is made to locate the canal so that there will be no stations in which the fill exceeds the cut, a large quantity of material will have been wasted, and the cost of the earthwork will have been greatly increased. This is no doubt a minor difficulty of irrigation construction, but it is one about which the writer would like to have a little information.

In some cases, elaborate plane-table sheets have been prepared, and a paper location has been worked up on them to be run in later in the field. On one location party with which the writer was connected, this plan was tried. It worked like a charm until a mistake of a foot or so in the levels run by the plane-table party was found, when the paper location, representing an outlay of several hundred dollars, was discarded, and a method quite similar to that described by the author adopted. Plane-table sheets of the locations of important structures are very desirable, but, in ordinary rolling country, the experienced locating engineer can get along very well without them.

The author states that monthly estimates can be made up from the cross slopes and the center line levels, to be corrected later in the final estimate. The writer has had some experience along that line. Such a scheme would work nicely were it not for the subcontractor. He does a few stations, is paid by the contractor from data given in the monthly estimates, and leaves the country. On the final estimate, the sub-contractor's yardage is cut down a few hundred yards, and the Engineer is called on for some embarrassing explanations as to how it all happened. The writer believes it is better to hold up the monthly estimate a few days, rather than give out quantities which have not been checked.

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THE DETROIT RIVER TUNNEL.

Discussion.*

By Messrs. H. A. Carson, H. F. Dunham, Charles B. Buerger, and August Gundersen.

Mr. Carson.

H. A. Carson, M. Am. Soc. C. E. (by letter).—In 1845, De la Haye, of England, suggested making a submarine railway by constructing wrought-iron tubes above water in sections 400 ft. long, bulkheading them so that they would float, towing them to the tunnel location, then admitting water, and sinking them to a suitable bed.

Since then many inventors have patented or published more or less practicable variations of this scheme. For example, in 1869, Martin and le Gay, of France, proposed a tunnel between France and England, consisting of metal tubes sunk to the bed of the Channel and surrounded by concrete. They proposed a feature afterward used at Detroit, of definitely limiting the exterior concrete by using sheathed frames fastened to, and sunk with, the metal tubes. In the following year a similar scheme was proposed by Mr. Thomas Page, an Englishman, who had been connected years before with the Brunel Tunnel under the Thames.

The writer does not know of any actual construction that followed De la Haye's suggestions until M. Belgrande, in 1866, built a pair of small pipe tunnels for sewers under the Seine, in Paris. Each had a diameter of 1 m., was 156 m. long, and was made of iron plate.

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* This discussion (of the paper by Wilson Sherman Kinnear, M. Am. Soc. C. E., published in *Proceedings* for August, 1911, and presented at the meeting of October 4th, 1911), is printed in *Proceedings* in order that the views expressed may be brought before all members for further discussion.

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Mr. Carson.

Since then there have been numerous examples, many of them interesting and ingenious, of iron water pipes sunk to the beds of rivers and harbors.

The first masonry tunnel of the De la Haye class, and also the first of this kind large enough for men to walk through erect, of which the writer knows, was constructed by himself, aided by Messrs. W. Blanchard, W. B. Smith, and other able assistants, when in 1893-94, he built, without the intervention of contractors, the Metropolitan sewer in the outer portion of Boston Harbor. The details in 1893 were slightly different from those in 1894; it will suffice to describe the latter. These tube sections were made of a combination of brick and concrete, with exterior wooden staves, 4 in. thick. The tube sections had external diameters of a little more than 9 ft., and were 50 ft. long. Temporary water-tight bulkheads were inserted at each end, and external flanges for bolting the contiguous sections end to end, were provided. These bulkheaded sections were tested for air-tightness, and inferentially for water-tightness, by exhausting the air and measuring the degree of rarefaction with a vacuum gauge. The weight of the sections relative to their displacement was such that they would barely float in sea-water. They were made in cradles, above water, alongside of a wharf. After completion and bulkheading, they were lowered by long vertical screws, moved by steam power. The sections were then towed from ½ to ¾ mile to their position for lowering, and, by admitting water, were sunk to saddles accurately fixed in a trench dredged in the gravel of the Harbor. When a section had been laid within a few inches of its predecessor, the two were bolted together, end to end, by divers. A rubber gasket was provided at each end between the flanges. The subsequent operations consisted of backfilling the trench around and over the pipes, removing the bulkheads successively, beginning at the land sections, and pumping out the water. At each joint, between two consecutive sections, a short closing length of masonry had to be put in to make good so much of the interior adjacent walls as had been occupied by the bulkheads. This was accomplished without difficulty as the rubber gaskets had made the joints perfectly water-tight. As these gaskets were outside the masonry, the fact that they would become disintegrated in time was not a matter of consequence. It was found that the whole tunnel, 1 500 ft. in length, was perfectly water-tight at the joints and elsewhere, true to line and level, and satisfactory in every way.

When the writer became a member of the Advisory Board of the Detroit Tunnel, he proposed a similar method, referred to by Mr. Kinnear, as Design *B*.* He did not propose an outer surrounding volume of concrete, on account of its expense. He admitted, however, that a large expense was justifiable in protecting a tunnel the top of which was brought up to the bottom of a river having such a heavy floating traffic. The possibility of a foundered vessel resting on the tunnel was constantly kept in mind by the Advisory Board. Mr. Carson.

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* *Proceedings*, Am. Soc. C. E., August, 1911, p. 912.

The scheme proposed by Mr. Wilgus at Detroit was not merely a reinvention of that of Martin and le Gay. It possesses in addition thick inside walls and other important features.

In 1877, a well-known engineer, William Sooy Smith, M. Am. Soc. C. E., proposed to construct a tunnel under the river at Detroit by sinking pneumatic caissons such as used in making bridge piers. These caissons were to touch one another, end to end, under the river, and in them the tunnel was to be built. It is an interesting fact that the general features of the French scheme of Martin and le Gay was recently used at Detroit at the same time that the basic features of the American plan of Sooy Smith was being used in Paris, in connection with the crossing of the Metropolitan Subway under the Seine. Each scheme had been re-invented, with important modifications.

H. F. DUNHAM, M. AM. SOC. C. E. (by letter).—Comments relating to the details of the work described in this remarkable paper will merely emphasize the ingenuity, boldness, and successful completion of the project as a whole. Mr. Dunham.

Had it been desired to check further the elaborate and rather expensive transfer of elevations across the river, half a dozen lengths of ½-in. pipe and two similar metal floats costing 50 cents, more or less, might have been used, and the averages of a few simultaneous readings on opposite sides of the river duly recorded. These averages might have been taken with confidence in place of the high-grade instrument work, and, like that work, found to be corrected automatically for curvature, radiation, and instrumental errors.

Readers of the paper will wish the author had given more space to a description of the steps by which the methods suggested originated or were shaped up for actual work; and to an explanation of why one method instead of another was finally adopted.

No one feels more keenly than the writer the great difference between the description of a scheme and of an accomplished work. The task performed is the scheme embodied and made permanent. That should satisfy. Yet there is a relation between methods in novel work which, for its real value, must depend in part on the work done. This might be illustrated by inquiring whether the author now considers Design *A* superior to Design *B*. It often happens that one part of a piece of work is more, and another part less, difficult than a builder anticipated. Has experience in connecting comparatively thin-walled sections made it evident that sections with thick walls would be unmanageable?

In sinking to its position, during a "June rise" in the Ohio River, Mr. Dunham. a heavy timber grillage with a coffer-dam and many courses of pier masonry for a 525-ft., double-track railway span, the writer found that it was possible to hold and control a large unit in a swift current. From this experience came ideas of tunnel sections, and, for one gravelly location, plans were made and protection obtained to promote the interests of a company. The work, however, was not undertaken, and no reference would be made to it here except that the methods and claims intended to further one piece of work (and not to interfere with another, since that would be unprofessional), have much in common with the work under discussion.

The double or twin-tunnel section, with transverse working openings through which concrete or other material could be deposited to secure a good foundation, was illustrated and claimed. The use of dowels to draw the sections together, the bulkheads, and the methods of unwatering were the same. In one or two respects, however, there were differences: It was proposed to lower a section, and, after making it secure and firm, to use it in lowering and guiding another section into position; each section was to be heavy enough to withstand the exterior pressure; and the work was to be done with little aid from divers. The details for a change of grade without a change in the method of holding one section firmly to another were worked out; also the plan of laying the sections each way from mid-stream and into comparatively shallow water where possible.

An interesting feature in the description of the work done by the author is the use of air cylinders instead of boats or scows to control a section as it was being placed. Were the cylinders used on account of cheapness, or to give better control?

The excellent quality of the concrete was due, in part, at least, to the pressure, and filling of voids in the tubes, and from the pressure of the water above when the concrete was finally deposited.

The reason for filling one or two sections with solid concrete is not fully explained; but it is far easier to ask questions about the work than it is to formulate in word the credit which the design and its execution merits.

Mr. Buerger. CHARLES B. BUERGER, ASSOC. M. AM. SOC. C. E. (by letter).—The unwatering of the river sections of the tunnel after the completion of the concreting, as described by Mr. Kinnear, would seem to permit of a simpler method.

Provide each section at its lower end with an outlet pipe, say, 6 in. in diameter, starting near the bottom plates, and leaving the tube through the top, with a valve above the concrete line. Make a hose connection to the top 2-in. air-escape valve used in sinking the tube, and force air into the tube by a compressor. Each section could be unwatered independently of the others with only a 2-in. hose as connection. A whole section would be emptied in 24 hours (not allowing for leakage) by a small compressor with a capacity of 250 ft. of free air per minute. With a pressure difference of only from 0 to 10 lb., between the inside and the outside of the tube, a generous allowance for leakage would not increase the requirements to more than 500 ft. of air per minute, and the whole of this discharge could pass through the 2-in. hose. The additional power required would not seem to be a serious objection. Mr. Buerger.

August Gundersen, Assoc. M. Am. Soc. C. E. (by letter).—Mr. Kinnear describes the four preliminary designs for the subaqueous section submitted by the Board of Engineers, on which contractors were asked to bid, but does not mention the development of the method actually used, nor its originator; nor does he state the reasons why none of the four designs submitted by the Board was used in the actual work. Mr. Gundersen.

In the interest of the history of subaqueous tunneling, and in order to amplify Mr. Kinnear's paper in this respect, the writer will present his knowledge of these matters, gained during three years' work, as Assistant Engineer to Olaf Hoff, M. Am. Soc. C. E., Vice-President and Engineer of the tunnel contractors, regarding the development of the method used, from its inception until its success was established.

A study of the preliminary designs submitted by the Board of Engineers soon revealed several practical and serious objections, a few of which are as follows:

Design A.—First, it would have been almost impossible to make even reasonably good concrete in a large open trench in deep water, as required by this method. Secondly, the quantity of concrete required to fill the trench to a sufficient height above the tunnel tubes proper, which were later to be built inside, would have been excessively large, even if the trench could have been dug to neat lines; actually, this quantity would have been increased enormously on account of difficulties in dredging accurately, which was plainly proved during the work. Thirdly, water-proofing the exterior concrete and building the tunnels inside under air pressure would have been both expensive and troublesome.

Design C.—This design was better than *A*, in so far as it utilized steel tubes, and thus avoided the use of air pressure; otherwise, it had the same defects.

Design B.—This design was more economical than the others, with respect to the quantity of concrete used, and the concrete in the tubes could have been made of good quality; but it would have required very expensive equipment for handling large sections with accuracy and safety. The La Salle Street Tunnel, in Chicago, affords an example of these difficulties on a small scale. Besides, there would have been many difficult joints to be made between sections, and there

Mr. Gundersen. remained the very serious question of a good supporting bed for the sections.

Design D.—The objections to a shield-driven tunnel under high pressure are so well known that they need not be mentioned here.

The submission of these four alternative methods by the Board of Engineers did not, in view of the objections stated above, solve the old question "how to build a subaqueous tunnel in an excavated trench." The first solution of this problem, as carried out at Detroit, is entirely due to the ability of Mr. Hoff, who developed this method and secured the contract for his firm.

Mr. Hoff gave his whole time and energy to the problem, and overcame the objections to the designs submitted by the Board of Engineers, as already stated. Gradually he developed the design and method described in Mr. Kinnear's paper: First, by introducing an outside form, rigidly connected to a set of steel tubes and to be sunk together with these, thereby limiting the exterior concrete to the quantity needed to counterbalance the buoyancy of the empty tubes, without wasting any concrete. Secondly, by introducing solid steel diaphragms between the outside forms and around the steel tubes, serving three purposes: (*a*) dividing the room between the outside forms and the tubes longitudinally into a series of pockets, making it possible to produce a good homogeneous concrete without seams or voids (the splendid quality and strength of such concrete is mentioned in the paper); (*b*) connecting the outside forms rigidly to the steel tubes; (*c*) stiffening these tubes most efficiently, so that it was necessary to make the steel shell only heavy enough to resist the hydrostatic pressure, thereby saving in steel, which is a large item in the cost of building good subaqueous tunnels.

These inventions, made by Mr. Hoff, and later patented by him, have made it possible to build subaqueous tunnels successfully, as done at Detroit. As a matter of courtesy to the Chairman of the Board of Engineers, Mr. Hoff named his design "Modification of Design *A*," although, as a matter of fact, the two designs have nothing in common except the open trench.

During the construction, the writer had the pleasure of developing all the details, as well as the general plans, for carrying out the work under Mr. Hoff's supervision and direction. Most of this work was original, as there were no precedents. If ever a monumental piece of work was constructed strictly in accordance with careful plans and studies, it was the subaqueous section of the Detroit River Tunnel. It is with pardonable pride, therefore, that the writer, in the interest of the truth and the development of the science of subaqueous tunneling, presents these facts which have been omitted in Mr. Kinnear's paper, otherwise so complete and excellent.

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AMERICAN SOCIETY OF CIVIL ENGINEERS

INSTITUTED 1852

PAPERS AND DISCUSSIONS

This Society is not responsible for any statement made or opinion expressed in its publications.

PIONEER RAILWAY DEVELOPMENT IN THE UNITED STATES.

Discussion.*

By Messrs. Marshall R. Pugh, R. L. Morrison, William J. Boucher, and George T. Hammond.

Mr. Pugh.

Marshall R. Pugh, M. Am. Soc. C. E. (by letter).—In his account of the early development of railroads in the United States, the author refers to the tramway at Quincy, Mass., constructed in 1826, as being the first. This tramway, however, was antedated by one in Delaware County, Pa., which was built by a Scotch millwright named Somerville, under the direction of John Thomson, a civil engineer, in September, 1809. This was an experimental piece of track, 60 yd. long, executed for Thomas Leiper, of Philadelphia. It had a gauge of 4 ft., a grade of 4 per 100, and the rails, of which the writer has no details, were carried on sleepers spaced 8 ft. apart. A loaded car was run on this track so successfully that Mr. Leiper built a road about 1 mile long, running from his quarry on Crum Creek to his boat landing on Ridley Creek, in Delaware County, and this road continued in successful operation for nineteen years.†

In 1815 a law was passed by the New Jersey Legislature authorizing Colonel John Stevens to construct a railroad from Trenton to New Brunswick, but nothing was done. On March 31st, 1823, Colonel Stevens secured a charter from the Pennsylvania Legislature to construct a road from Philadelphia to Columbia, on the Susquehanna,

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* This discussion (of the paper by the late W. D. Taylor, M. Am. Soc. C. E., published in *Proceedings* for August, 1911, but not presented at any meeting), is printed in *Proceedings* in order that the views expressed may be brought before all members for further discussion.

† Sipes', "The Pennsylvania Railroad," Philadelphia, 1875.

In the *Proceedings* of this Society, the Papers and the Discussions on Papers will hereafter be printed so that each will commence on an odd-numbered page. This is done by special request, in order to enable members who wish to do so to separate the Papers and Discussions for filing under various engineering subjects.

Mr. Pugh. Stephen Girard being one of the corporators. This anticipated the present charter of the Pennsylvania Railroad, but it was repealed in 1826, before anything had been accomplished.

During 1826 and 1827 the Delaware and Hudson Canal Company started to build lines to bring anthracite coal from the Susquehanna Valley across to Tidewater, employing a young civil engineer, Horatio Allen.* Mr. Allen writes:†

> "Early in the year 1827, I had given all the attention that it was in my power to give, and having come to conclusions as to the locomotive, that all subsequent experience has confirmed, and believing that the future of the civil engineer lay in a great and most attractive degree in the direction of the coming railroad era, I decided to go to the only place where a locomotive was in daily operation, and could be studied in all its practical details."

Mr. Allen left the Delaware and Hudson Canal Company preparatory to going to England, and the Company decided to intrust him with the commission of securing for them from England their railroad iron and three locomotives, on plans to be approved by him. Thus the first order for a locomotive, after the success of the Stockton and Darlington engine, came from an American company on the advice of an American civil engineer.

Mr. Taylor has referred to the failure of the Delaware and Hudson locomotives as being due in part to their not having Stephenson's last improvement, the multitubular boiler; but Mr. Allen‡ writes quite at length:

> "As to the boiler, the result on my mind was a decided confidence in the multitubular boiler proposed by Mr. Booth, of the Liverpool and Manchester road, but I found in many a distrust of that plan of boiler as being an *untried* boiler. John U. Rastrick, of Stourbridge, * * * recommended a boiler of small riveted flues of as small a diameter as could be riveted, and in number as many as the end of the fire-box would allow."

Mr. Allen ordered two locomotives from Stephenson and one from Foster, Rastrick and Company, of Stourbridge.§

> "The only points decided by me were that the boilers of the locomotives built by Stephenson & Co. were to be multitubular boilers; and that the boiler of the locomotive built by Rastrick & Co. (the 'Stourbridge Lion') was to be a flue-boiler."

These engines reached New York in the winter of 1828-29, and in the spring, the *Stourbridge Lion,* which owed its name to a fierce and resplendently colored lion painted on the end of the boiler, was brought by river and canal to Honesdale, Pa. It is not known how this engine came to be sent, but it is unfortunate that one of Stephenson's was not chosen, as they were the prototypes of the *Rocket* whose epoch-making trip took place in October of the same year.

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* Mr. Allen was subsequently the Fifth President of the American Society of Civil Engineers.

† "The Railroad Era," p. 13, New York, 1884.

‡ *Ibid*, p. 17.

§ "The Railroad Era," p. 17.

Mr. Pugh.

That first trip of a steam locomotive on the American Continent is best told in the words of the man who made it, Mr. Allen himself driving the engine.†

"The line of road was straight for about 600 feet, being parallel with the canal, then crossing the Lackawaxen Creek, by a curve nearly a quarter of a circle long, of radius 750 feet, on trestle-work about thirty feet above the creek, and from the curve extending in a line nearly straight into the woods of Pennsylvania.

"The road was formed of rails of hemlock timber in section six by twelve inches, supported by caps of timber ten feet from centre to centre. On the surface of the rail of wood was spiked the railroad iron—a bar of rolled iron two and a quarter inches wide and half an inch thick.

"As the locomotive was seen in mid-air, in its transference from the canal to the railroad, the opportunity was had to see that the axles had an unyielding *parallel* position, there being no king-bolt that provided facility for passing round the curve, and that therefore, the four wheels holding their rigid position were to be forced round the curve by the power of the steam-engine. The locomotive thus seen altogether impressed the lookers-on as being of great weight. The road having been built of timber in long lengths, and not well-seasoned, some of the rails were not exactly in their true position when the time came that they were to carry the locomotive in its onward movement.

"Under these circumstances the feeling of the lookers-on became general, that either the road would break down under the weight of the locomotive, or, if the curve was reached, that the locomotive would not keep the track, and in its onward motion without support it would dash into the creek with a fall of some thirty feet.

"On my part, I knew that the road would carry the locomotive safely, and that the curve would be passed without any difficulty.

"But when the time came, and the steam was of the right pressure, and all was ready, I took my position on the platform of the locomotive alone, and with my hand on the throttle-valve handle said: 'If there is any danger in this ride it is not necessary that the life and limbs of more than one should be subjected to that danger; that, having no doubt whatever, I was about to take the ride entirely alone, and that the time would come when I should look back with great interest to the ride that was now before me.'

"The locomotive, having no train behind it, answered at once to the movement of the hand, and there being no doubt as to the result, a motion was had at once in which there was not any evidence of distrust; soon the straight line was run over, the curve was reached and passed before there was time to think as to its not being passed safely, and soon I was out of sight in the three miles' ride alone into the woods of Pennsylvania.

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† *Ibid*, p. 20 *et seq.*

Mr. Pugh. "I had never run a locomotive nor any other engine before, I have never run one since; but on that 9th of August,* 1829, I ran that locomotive three miles and back to the place of starting, and being without experience or a brakeman, I stopped the locomotive on its return at the place of starting. After losing the cheers of the lookers-on, the only sound, in addition to that of the exhaust steam, was that of a timber structure when the parts are brought into the bearing state."

At this time Mr. Allen had just received his appointment as Chief Engineer of the South Carolina Railroad, and though the Baltimore and Ohio was now under construction, the South Carolina line, completed in 1835, from Charleston, S. C., to Hamburg, opposite Augusta, Ga., a distance of 135 miles, was the longest railroad in the world. With this length of line, night operation of trains became a necessity. The expedient adopted by him for the first locomotive headlight is rather amusing.†

"That the locomotive was to be used in the night, and during the whole night, was plainly to be anticipated. It was thought well to make trial of such running by night, that it might be known what it was necessary to provide. For such trial two platform cars were placed in front of the locomotive. On the forward platform was placed an inclosure of sand, and on the sand a structure of iron rods somewhat of urn shape. In this structure was to be kept up a fire of pine-wood knots. Suitable signals as to the rate of speed, etc., were provided. The day preceding the evening of the trial closed in with as heavy a fog as I have ever seen, and I have seen a first-class London fog. But the fog did not prevent the trial when the appointed time came.

"The country to be run through was a dead level, and on the surface rested this heavy fog; but just before we were ready to start, the fog began to lift and continued to rise slowly and as uniformly as ever curtain left surface of stage, until about eighteen feet high; there it remained stationary, with an under surface as uniform as the surface it had risen from. This under surface was lit up with radiating lines in all directions with prismatic colors, presenting a scene of remarkable brilliancy and beauty.

"Under this canopy, lit on its under surface, the locomotive moved onward with a clearly illuminated road before it; the run was continued for some five miles, with no untoward occurrence, and I had reason to exclaim, 'The very atmosphere of Carolina says, "Welcome the locomotive."'"

At about the same time, 1834, the State of Pennsylvania had a line extending from Philadelphia to Pittsburg, consisting in part of railroad and in part of canal. The first 82 miles from Philadelphia to Columbia was rail; then came 172 miles of canal to Hollidaysburg. The Portage Railroad, 36 miles in length, extended to Johnstown, and from there there were 104 miles of canal to Pittsburg, a total distance of 394 miles. It was operated by horses until 1836, when

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* Contemporary records seem to show that it was the 8th of August.

† "The Railroad Era," p. 28.

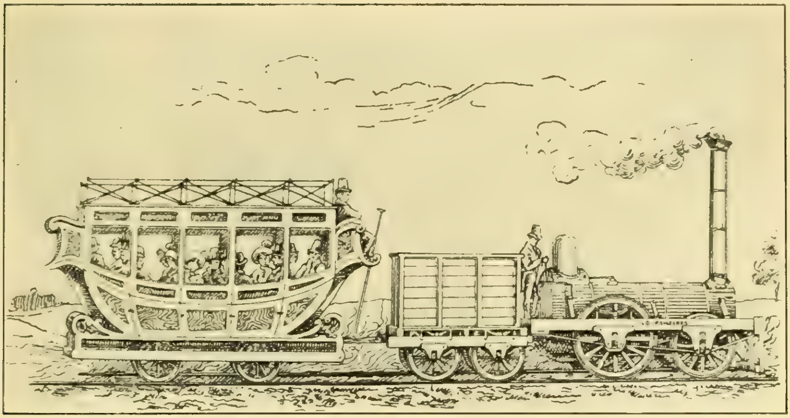

FIG. 1.—"OLD IRONSIDES."

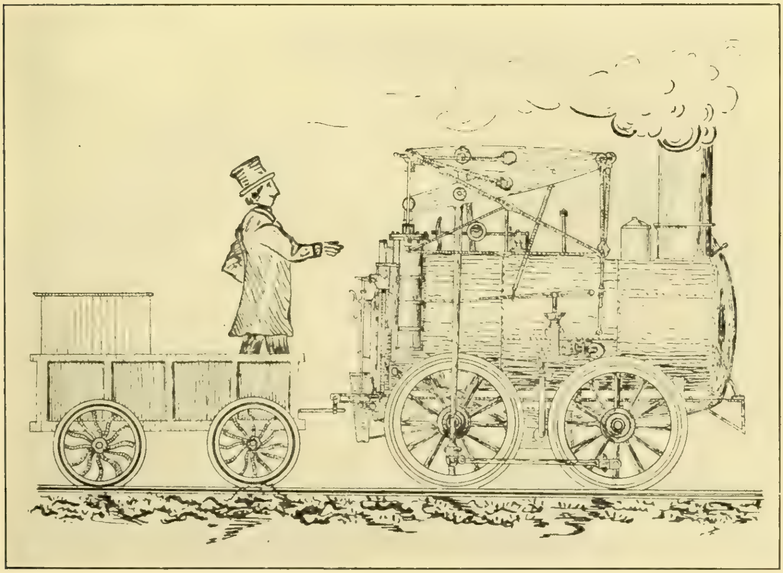

FIG. 2.—THE "STOURBRIDGE LION."

locomotives were put on. Thereafter the State furnished the motive power, while the cars were the property of individuals, who paid regular rates of toll for being drawn by the engines, and for the use of the tracks. Mr. Pugh.

The Germantown and Norristown Railroad, from Philadelphia to Germantown, is interesting as having had the first successful American locomotive, *Old Ironsides.* The Delaware and Hudson engines were English, and moreover failed to satisfy American conditions. Peter Cooper's locomotive, the *Tom Thumb,* was an experiment only; the *Best Friend,* and the *West Point,* built at Cold Spring, N. Y., for the South Carolina Railroad, and the *DeWitt Clinton,* built at the same place for the Mohawk and Hudson Railroad, were like the English engines, with rigid axles, and did not meet American needs. The Germantown and Norristown road was laid out under the direction of its Chief Engineer, J. Edgar Thomson, subsequently Chief Engineer, and then President, of the Pennsylvania Railroad. It was opened for use with much ceremony on June 6th, 1832, the event being one of such importance that among the guests were the Councils of New York City. The cars, or carriages, made in Baltimore, were drawn by horses until November 22d, when *Old Ironsides,* Baldwin's first locomotive, made her trial trip. This engine, the first product of the Baldwin works,* weighed more than 5 tons. The spokes of the wheels were of wood, as were the rims, the tires being of wrought iron and the hubs of cast iron. Such a marvel was this machine that the President of the Railroad Company, fearing that some fatal accident might occur, usually rode on the train on its trips. Notice was given that when it rained horses would draw the cars, as the engine was not taken out in the wet.

Schedules were not strictly adhered to. An old gentleman has stated that he went to the station intending to ride out on the train, and, though he was early, he was told that it had started quite a little while before. The ticket agent said that the Directors were to feast in Germantown, and, to avoid the dire disaster of a cold dinner, had started the train half an hour ahead of the proper time.

The earliest engines had no whistles, signals being given by pushing up the safety valve and allowing the steam to escape with a noisy hiss. Loose chain couplings and the entire absence of brakes gave rise to a most exhilarating series of jolts and jerks in starting and stopping. On the New Castle and Frenchtown Railroad, when the signal of an approaching train was heard, the slaves around the station would rush up to it and seizing hold of the cars, drag back on them with might and main, while the ticket agent stuck a stout stick through a wheel, and the whole train was thus gracefully brought to a standstill.

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* Mr. Baldwin had so much trouble in constructing this engine that he vowed he would never make another. How well he kept his vow is shown by the fact that in the early part of 1907, the Baldwin works had turned out its 30 000th locomotive.

Mr. Pugh. Some roads in the Cotton Belt had a flat car, piled with bales of cotton, placed between engine and train—a so-called barrier car. In event of a boiler explosion, it was thought that the passengers would be protected, and in case of collision they would simply be pitched head first into a sort of mattress or soft cushion. The writer has no reports on its operation under "service conditions."

Mr. Morrison. R. L. MORRISON, JUN. AM. SOC. C. E. (by letter).—The first railway mentioned in the paper is the line from Wandsworth to Croydon, which was chartered in 1801. This was the first chartered railway, but it may be of interest to note that the first English railway of which there is any record seems to have been located at Newcastle-on-Tyne, at the coal mines, and is described by Roger North, who saw it in operation in 1676. He says:*

"Another thing that is remarkable, is their way-leaves. * * * The manner of the carriage [of coal] is by laying rails of timber, from the colliery, down to the river, exactly straight and parallel; and bulky carts are made with four rowlets fitting these rails; whereby the carriage is so easy that one horse will draw down four or five chaldrons of coals, and is an immense benefit to the coal merchant."

A Newcastle "chaldron" is somewhat more than 72 bushels, heaped up, or 5 300 lb. Robert Stephenson says† these "way-leaves," or railways, were in use before 1671.

For many years these railways were used only at mines, and had wooden rails. In 1767 the scarcity of timber in England led to the introduction of solid rails of cast iron, which were supported at the joints by blocks, first of timber and afterward of stone. The first rails were flat, but in 1789 "edge-rails" were introduced.‡

Although Mr. Taylor does not state that the locomotive built by Stephenson in 1814 was the first ever constructed, the reader might easily get that impression. In 1801 Oliver Evans, of Philadelphia, constructed a dredging machine which was mounted on wheels and conducted under its own steam through the streets of the city to the Delaware, a mile distant.§ Evans' one contribution to science was the non-condensing, high-pressure, steam engine which impelled this strange device.||

The first English locomotive was designed by Richard Trevithick, a Cornish mine engineer, in 1804, and was successfully operated on common roads.** Trevithick built an improved locomotive in 1808.

In 1813, William Hedley and Timothy Hackworth succeeded in constructing the first locomotive which was run on rails. This was

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* "Lives of the Norths," Pt. I, pp. 281–282.

† "Life of Robert Stephenson," p. 115.

‡ Cleveland and Powell, "Railroad Promotion and Capitalization."

§ *New York Review*, III, pp. 95–96.

|| Thurston, "History of the Steam Engine," p. 153.

** Niles, III, Addenda, p. 5.

Mr. Morrison.

called the *Puffing Billy*, and was an engine with two vertical cylinders. George Stephenson, who was employed at a neighboring colliery, built a locomotive closely following that of Hedley.*

The tramway built at Quincy, Mass., in 1826, is mentioned by Mr. Taylor, as being the first tramway in America. Cleveland and Powell, in discussing tramways, state:†

"The earliest work of the kind in this country appears to have been constructed by Silas Whitney, of Boston, on Beacon Hill, in 1807. Two years later, Thomas Leiper built a tramway to connect his quarries on Crum creek, Delaware county, Pennsylvania, with tide-water on Ridley creek, a distance of about three-quarters of a mile. This was in constant use until 1828. Other similar structures were laid down at Falling's creek, Chesterfield county, Virginia, soon after 1810; at Bear Creek Furnace, Armstrong county, Pennsylvania, in 1818; and at Nashua, New Hampshire, in 1825."

Mr Boucher.

William J. Boucher, Assoc. M. Am. Soc. C. E. (by letter).—Mr. Taylor has prepared a very interesting paper on early railways, and deserves credit for his painstaking account; the thanks of the Engineering Profession are due him for thus recording these important historical facts in such a readable manner.

The writer desires to add to the history, and, at the same time, pay deserved tribute to the Stevens family, of Hoboken, N. J., founders of the Stevens Institute of Technology; a family which has stood at the very forefront of engineering achievement since the beginning of the Nineteenth Century. John Stevens and his sons, Robert L. and Edwin A., possessed to a marked degree those characteristics which distinguish the modern engineer; their ability to solve problems and forecast the future was indeed ahead of their day.

Long before any locomotive was constructed in Europe, John Stevens had clearly worked out, in his own mind, the theory of such an application of steam, and the actual form in which it could be advantageously made, as well as the cost of constructing and working a railway for the use of locomotives. Long before there was any experience to justify his anticipation, he said and published, "that there was no limit to the speed of a locomotive on a rail, but the strength of the materials, indeed it might easily be made to run as fast as a pigeon could fly;" and it is one of the striking incidents connected with the early days of the Camden and Amboy Railroad (now part of the Pennsylvania system in New Jersey) that a flock of pigeons, which had settled on the track, being disturbed by the rapid approach of the engine, took wing in the direction the train was moving, and one of them, attempting to cross in front of it, was struck down, thus most literally verifying the prediction made.

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* Sinclair, "American and Foreign Locomotives," New England Railroad Club, *Proceedings*, January, 1902.

† "Railroad Promotion and Capitalization," p. 60.

Mr. Boucher.

In 1810, while discussion was going on relative to the project of connecting Lake Erie with the Hudson River, Col. John Stevens, after seeing the report, which contemplated a canal with locks, earnestly pressed upon the Commissioners the consideration of a system of railways adapted to the use of carriages propelled by steam locomotives, as being preferable in economy, speed, and rapidity of construction. In 1812, he published his views in a pamphlet entitled "Documents Tending to Prove the Superior Advantages of Rail-ways and Steam Carriages Over Canal Navigation," which is practically a copy of his memorial to the Commissioners, with their objections and his rejoinders. In it he writes of the advantages to the public and to the Federal Government in the collection of tolls and in the protection of distant points from invasion by an enemy, and again refers to the possible speed, which might equal 100 miles per hour, but considers it probable that it may not in practice be convenient to exceed 20 or 30 miles per hour.

In an address delivered by the late J. Elfreth Watkins, Assoc. Am. Soc. C. E., before the Philosophical Society of Washington, D. C., on May 7th, 1892, on "John Stevens and His Sons, Early American Engineers," he said:

> "The South Carolina Railroad (commenced in 1829) which, when completed in 1832, was the longest railway in the world, was constructed upon his plans, as laid down 20 years before."

In the early part of the last century, the principal route of traffic between New York and Philadelphia was by water from New York to New Brunswick, then overland to Trenton, then down the Delaware River to Philadelphia. John Stevens was associated with the firm which controlled this route, and he, seeing the advantages which would be possessed by a rail line over the wagon roads, in 1817 obtained a charter from the State of New Jersey, "to build a Railroad from the river Delaware, near Trenton, to the river Raritan, near New Brunswick." This is undoubtedly the earliest railroad charter granted in America, but no tangible result followed, because the scheme was regarded as wild and visionary. Col. Stevens regretted that his financial condition was not such as to warrant him in building the road at his own expense. His interest in the subject did not flag on account of this failure, for, in 1823, through his exertions, acts were passed by the Legislature of Pennsylvania for the incorporation of a company to construct a railway from Harrisburg to Pittsburg, and another company to construct a railway from Philadelphia to Columbia, in Lancaster County, among the incorporators being John Stevens, Stephen Girard, and Horace Binney.

In 1826, Col. Stevens, then 76 years of age, constructed at his own expense a locomotive with a multitubular boiler, which he operated for several years on a circular track on his estate at Hoboken.

"This was the first locomotive in America driven by steam upon a track, of which there is any reliable record."* Mr. Boucher.

A model of this locomotive, together with the original multitubular boiler which formed a part of it, is preserved in the National Museum at Washington.

On April 12th, 1830, was held the first meeting of stockholders, at which the organization of the Camden and Amboy Railroad was effected. The following persons were chosen the sole officers and directors of the company: Robert L. Stevens, of Hoboken, President; Edwin A. Stevens, of Hoboken, Treasurer; Jeremiah H. Sloan, of Camden, Secretary. Robert L. Stevens was also appointed Chief Engineer. The brothers, Robert L. and Edwin A. (with their father, John Stevens), became the active managers of the road. The former took charge of laying the track and procuring the equipment, while the latter looked after the political, financial, and practical management of affairs. Considerable judgment had to be used in both these branches. No laws had been established in regard to the steps to be taken in the purchase of right of way, and many of the New Jersey Legislators were very chary when they were asked to grant franchises and rights. In the matter of construction and equipment, these early engineers had little or no experience to guide them, and they had to resort to experiment and trial.

The road, the first link of the present Pennsylvania system, was completed and formally opened for traffic, from Bordentown to Hightstown, N. J., on October 9th, 1831. In December of the same year it was opened to Amboy, but locomotives were not used until August, 1833, when a sufficient number had been built.

Robert L. Stevens advocated the use of an all-iron rail, in preference to the wooden rail plated with strap-iron then in use on some of the American railways. At a meeting of the board of directors of the Camden and Amboy Railroad, a special resolution was passed, authorizing him to obtain the rails he advocated. At that time, there was no mill in America capable of rolling such rails as he had in mind, therefore, soon after this, he sailed for England. On the voyage, he passed hours in whittling thin wood into shapes of imaginary cross-sections, until he finally decided which one was best suited to the needs of the new work. He was familiar with the Birkenshaw rail, with which the best English railroads were then being laid, but he observed that as it required an expensive chair to hold it in place, it was not adapted to conditions in America, where metal workers were scarce and iron was high in price.

He devised the base to the T-rail, thus dispensing with the necessity for the chair. He also designed the hook-headed spike (which is substantially the railroad spike of to-day), and the "iron tongue," which

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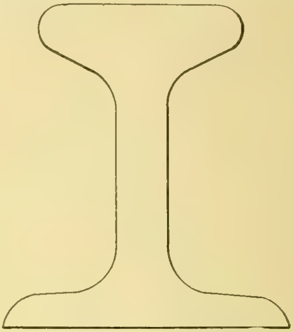
* J. E. Watkins, Address at Washington, D. C., May 7th, 1892.

Mr. Boucher. has developed into the fish-plate or angle-bar, and the rivets (which have been replaced by bolts and nuts) to complete the joint. Thus, with his all-iron rails, spiked to wooden ties, he first produced the type of track which is in general use throughout America at the present time.

Much difficulty was experienced in obtaining a mill to roll the newly-designed rail, for not only were no rolls in existence and the cost of their making was large, but there was also much doubt as to the practicability of rolling such a shape. An iron-works in Dowlais, Wales, however, was prevailed upon to attempt the work, Mr. Stevens being required personally to guarantee payment for damages to the rolling machinery in case of breakdown. On coming from the rolls, the rails were crooked and twisted, but, by peristence, he showed the mill men how to straighten them while they cooled. The first rails weighed 36 lb. per yd., but, very soon, the weight was changed to about 40 lb. per yd., and they were rolled in 16-ft. lengths, the latter rails being 3½ in. high, 2⅛ in. wide at the head, and 3½ in. wide at the base. With the exception of slight alterations in the proportions, incident to the increased weight, the rail, as designed by Mr. Stevens and first used in the Camden and Amboy track, is the rail of to-day. The price of these rails, in England, was £8 per ton, and the import duty was $1.85 per ton.



CROSS-SECTION OF ROBERT L. STEVENS' FIRST T RAIL.

FIG. 2.

On the occasion of the opening of the Carnegie Laboratory of Engineering at Stevens Institute, on February 6th, 1902, a piece of one of these original rails was presented to Mr. Andrew Carnegie, with appropriate ceremonies, and accompanied by the documentary proofs of genuineness.*

Mr. Hammond. GEORGE T. HAMMOND, M. AM. SOC. C. E. (by letter).—The student of engineering history, who seeks, in the publications of this Society, for data concerning interesting structures which, at an early day in our art, have been of importance in railway development in the United States, will find one item which will strike him as curious, and will prove somewhat of a mystery, if he attempts to find out much about it.

The writer refers to the picture† entitled "Tunnel under Part of Atlantic Avenue, Brooklyn (from a Crayon Sketch)." Examining this picture, he will see the entrance of a horse-shoe shaped tunnel structure for a two-track railroad, about 21 ft. wide and 17 ft. high,

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* The foregoing is largely taken from the "Morton Memorial Volume," published 1905 by the Alumni Association of the Stevens Institute of Technology.

† *Transactions*, Am. Soc. C. E., Vol. LXVIII, Plate IV, p. 36.

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out of which issues a train drawn by a locomotive engine of very early design, and he will observe the legend at the top of the picture "Atlantic Ave. Tunnel, 1845." The text states that this tunnel was built by the Long Island Railroad Company in 1845, and operated under a portion of Atlantic Avenue, but later it was filled up.

As this tunnel was the first subway in New York City, and was in many ways a great undertaking at the time, it is of no little interest. The writer, having often come into contact with this work, and once at least into physical contact with it in the progress of sewer construction, of which he then had charge, had always found in it an interesting mystery. Why it was built, and why abandoned, and who might have been the Chief Engineer under whose supervision it was designed and erected, had always eluded him, until he chanced to see the statement, in Prime's "History of Long Island," published more than fifty years ago, that the Chief Engineer of the Long Island Railroad was James Shipman. Subsequent inquiry, following this clew, developed the interesting fact that James Shipman, or more correctly, James Ingraham Shipman, at one time a member of this Society,* who was Chief Engineer of the Long Island Railroad from about 1837 to 1847, was a man who contributed to railroad development in the United States, and at one time stood near the head of his profession, whose memory has been nearly, if not quite, forgotten. The few facts which the writer has been able to gather concerning him were obtained from his surviving son, Mr. James T. Shipman, of Farmingdale, Long Island, himself a civil engineer, who has for many years followed in the footsteps of his father as a railroad builder.

The Long Island Railroad, incorporated in 1834, was one of the first roads constructed in America, and must be given an important place in the progress of railway development. It was almost our first road, and none of our railroads antedated it more than five or six years. The purpose of this enterprise was to provide a main line between New York and Boston, by railroad to the east end of Long Island, and thence by steamboat to Boston. In the early days of passenger traffic, this was much the quickest way to reach the latter city from New York; later, the time was further reduced by a steamboat connecting with the Providence and Stonington Railroad and the Boston and Providence Railroad.

In 1844 the railroad was completed to Greenport, and during the following year the tunnel under Atlantic Avenue, Brooklyn, was built, greatly improving the grades between Bedford Station and South Ferry. The Long Island Railroad was constructed for what in those days was considered extremely high speed. It is recorded that the trip from South Ferry, Brooklyn, to Greenport was made in 3¾ hours,

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* In the List of Members for 1871 his name is printed erroneously J. J. Shipman, but in the 1873 List it is given correctly, James I. Shipman.

Mr. Hammond. and that it had been accomplished in the earliest days of the road in 2 hours and 35 minutes "with perfect safety," the distance being 95 miles. The railroad was completed to Hicksville, and trains were run thereon from South Ferry, Brooklyn, in 1837. Thence it was extended to Greenport during 1841-1844.

After the completion of the main line of this railroad, Mr. Shipman left its service, but returned to it as Chief Engineer, after an interval of about ten years.

On leaving the Long Island Railroad, Mr. Shipman removed to Illinois, where, during the period of 1847 to 1855, he was Chief Engineer of the Sangamon and Morgan Railroad and of the Alton and Sangamon Railroad; also of the Illinois Coal Company's Railroad, etc.

While Chief Engineer of the Alton and Sangamon Railroad (1852) he prepared a manual, published by that railroad company, entitled "Facts and Figures Illustrative of the Alton and Sangamon Railroad; with a Report on the Extension to Bloomington, Pekin, and Peoria." This curious publication, placed in the writer's hands by Mr. Shipman's son, affords such an insight into the early development of the art of railroad building, that a few extracts from it will be given.

It should be noted that the Alton and Sangamon Railroad was destined to become one of the main carriers of traffic in America, between Chicago and St. Louis. In clear and cultivated English, which might well be studied as a model in these days, Mr. Shipman tells of the problems solved in railroad building. He recommends that all bridges be built of iron; possibly this is the earliest recommendation for the use of this material in railroad bridges (1852). It would appear so, as he does not refer to a single instance of an iron bridge in use or recommended for this purpose, yet he seems to be quite familiar with the practice of that time, and refers to the great railroad enterprises built and projected as though he was fully informed. The mention of a single iron bridge for railway service would have strengthened his recommendation.

To select extracts from an original document, the whole of which is of interest, is not easy. The extracts which follow are but a small portion of the whole, but are general, and serve to illustrate the art of railway building sixty years ago.

"The Alton and Sangamon Railroad Company * * * chartered in the year 1847, * * * when completed will connect the capital of the State of Illinois with the Mississippi river, at its nearest practicable point, by a line of about seventy miles. The Road is to be an exceedingly important one, both from its local business, and from its connection with other roads. As a *local* Road, it must always constitute the outlet for the Central portions of Illinois, to the Mississippi river. The great fertility of this portion of the State is well known; and though Illinois, as a whole, is very sparsely popu-

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lated, the portions traversed by the above line will compare favorably with the best settled parts of Indiana and Ohio, and are not excelled, if equalled, by either in extent of natural resources.

* * * * * * *

"In looking at the prospective business of Western Roads, we believe a much more correct estimate can be found of its extent, from a general view of the productiveness and course of trade in that section, than from the most elaborate compilation of statistics drawn from existing data. The amount of production, and extent of movement of property, is now subordinate to the *means* of transportation. Some of the most fertile portions of Illinois are valueless, simply for the want of a suitable outlet to a market. Many sections, that are destined to be the most flourishing, are still covered with forests. In many portions of the State, the surplus of grains raised will not bear the cost of carriage to navigable waters. The rivers of Illinois, the present route of commerce, though invaluable in the absence of Railroads, are for a considerable portion of each year not available for transportation. From the commerce that has already been developed, we can form but a faint idea of what is to come, when the suitable avenues and instruments shall have been provided.

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"We find our own views of the extent and nature of the business on Western Roads, and the estimates which we have given above, strikingly confirmed in a recent pamphlet, put forth by D. A. Neal, Esq., one of the corporators of the Illinois Central Railroad, upon the prospective business and income from that great work. As Mr. Neal is admitted to be the very highest authority in reference to all matters touching Railroads, we propose to compare, as far as may be done, his estimates, with those which we have prepared in reference to the Alton and Sangamon Railroad, as far as a parallel between the two holds good.

"The *first* item in Mr. Neal's estimate of the business of the Central Railroad, embraces the articles of wood and coal. As our estimates fall below his, we keep our figures of revenue from these sources, viz.: $22,800.

"2nd. The second item in his estimate is 'the produce of the soil.' Upon this he says:

"'The second source indicated, from which the Road is to be sustained is the "produce of the soil." The transportation of Indian corn and other grain *will be the important business of the Road.* Their production will in time be limited by the capacity of the Road to carry it off. In an estimate of this sort then, it may be safe to neglect all other kinds of produce, or rather consider them as merged into the one article of maize or Indian corn. We have already restricted ourselves to a population in the district of country lying within fifteen miles of the Railroad, to the density of the whole State, by the census of 1850, or fifteen to the square mile. There will be, as before stated, 20,000 of such miles, and the number will of course be 300,000. A large portion of these will be male adults; but taking the usual calculation of five to a family, we have 60,000 families. Deducting again one-sixth for other employments, we have then 50,000

Mr. Hammond. families presumed to be in the cultivation of the soil. Now it cannot be doubted, I think, that ten families can easily till and take care of 1 000 acres of Indian corn in Illinois, by an interchange of labor. It is as certain that the land will give 50, 60, or 70 bushels to the acre. This gives an average of 100 acres of cultivated ground, and 6,000 bushels of corn to each family. But to be sure not to overtask the powers of the people, or of the soil, we reduce both one-half, 50 acres and 30 bushels per acre, giving to each family, 1,500 bushels. Of this, suppose one-third to be used in the family, and on the farm, and wasted. There remains 1,000 bushels. As a portion of this may be represented by less bulky and more valuable articles, we again reduce it one-third, to get at the weight that will require transportation to a market. This leaves us 666$\frac{2}{3}$ bushels of corn, or an equivalent in other things, and which, multiplied by the number of families, gives equal to 33,333,000 bushels of Indian corn. The usual mode is to estimate 33 bushels to the ton. At 33$\frac{1}{3}$ it gives 1,000,000 tons. The distance which it would have to be transported to market could not be less than 100 miles, and the price would be low at five cents per ton per mile. This would give $4,000,000!'

"Making the application with the substitution of 22 inhabitants to the square mile, instead of 15 (which, under the Census of 1850, we find to the square mile along the line of the Alton and Springfield Railroad,) and we have the following result: Length of Road, 72 miles. Number of square miles within 15 miles of the Road, 2,160; population 50,160,—farmers engaged in cultivation of the soil, 8,360; corn produced, 12,540,000 bushels; estimated amount of corn, or its equivalent, to pass on the Road, 5,573,333 bushels;—or, 666$\frac{2}{3}$ to the family, and amounting to 167,535 tons; which, at four cents per ton per mile, averaging the transportation at one half the length of the road, 38 miles, at $1 52 per ton, will yield a revenue of $254,653 20—more than double our estimate.

"3d. The third item is the return of freight, exclusive of coal and lumber; in relation to which Mr. Neal remarks:

" 'The returns that will be made to the producer of this large amount of property must bear some proportion to it in value and in bulk. If the corn nets but fifteen cents per bushel, it will give to each family $100; and to the 30,000 families, $5,000,000. To keep within bounds we will suppose that, exclusive of the lumber by the coal and other trains, only one-eighth of the outward tonnage is returned in supplies. This would give the Road, at the enhanced rate which such goods would bear, (say five cents per ton per mile) or $5 per ton, $625,000. Applying a similar estimate to the Alton and Sangamon Railroad, and we should have 20,941 tons, at five cents per mile per ton, averaging to be carried 38 miles; which, at $1 90 per ton, would give a revenue of $39,787 90.'

"4th. The 4th item is local travel; concerning which the following language is used:

" 'The local travel of the same population will be an item of some importance. They must be considerably scattered, and if they associate at all, they will use the Road. Each head of a family averages five journeys of 60 miles each, or 300 miles per annum, for the whole household. It will cause the Road to carry one passenger 18,000,000

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miles; which, at three cents per mile is $540,000. This would amount to nine dollars for each family per annum. If we reduce it one half, there can be little doubt of the other half being made up, and more than made up, by the other local passenger and freight business, such as those living without the line of twelve miles, of citizens of other States visiting the stations, and the thousand occasions for trips from the termini to the interior.' It seems safe then to let this item stand. Applying this estimate to the 8,360 families on the line of the Alton and Sangamon Railroad, and we have a revenue of $75,240 from this source.

"5th. The fifth item has reference to the through travel, which must depend upon so many conditions differing from those which belong to the Central Road, that we have thought it best to retain our own estimates of thirty through passengers each way per day, which, at three cents per mile, will give $53,640. Mail, 72 miles, $7,200; and we have the following

"Recapitulation:

"Freight of coal and lumber	$22,800 00	
Freight of produce of the soil	254,653 20	
Freight returning	39,787 90	
Local travel	75,240 00	
Through "	53,640 00	
Mail	7,200 00	
	$453,321 10	
Less expenses, 50 per cent	226,660 55	
		$226,660 55
—over 22 per cent. on the cost of the Road.		
Or if we take the above		$453,721 10
And deduct all the items not strictly calculated according to Mr. Neal's basis, to wit: items 1 and 5		76,440 00
We have still left		$377,281 10
Less expenses, 50 per cent		188,640 55
Leaving over 18 per cent. profit		$188,640 55

"We have been particular to give Mr. Neal's estimates, for the reason that he is connected with the greatest Railroad project now occupying the attention of our people, and exerts a strong influence in the direction of its affairs. His estimates are undoubtedly prepared with the greatest caution, and upon the most careful investigation, and deserve additional consideration from his justly celebrated reputation, of being one of our ablest and most successful Railroad men. He gives them as his own conviction, of what will be the results of the Central Railroad, upon a given state of facts. If they will prove true of the Central, they will equally so, of most of our Western Roads. They are certainly applicable in their fullest extent to the

Mr. ammond. Alton and Sangamon Railroad, as the country traversed by this is richer, more densely populated, produces more to the acre, and is probably more fertile than the country traversed by the Central Road.

"We have thus far spoken only of the local business of the Alton and Sangamon Railroad. We may here add one or two general remarks in reference to the comparative amount of freights upon Eastern and Western roads:—1st. That all articles of Western export are of a bulky kind, and pay a large profit in proportion to their value. 2nd. That agriculture, being the leading pursuit in that quarter, all surplus raised is exported to distant markets, and must pass over Railroads when constructed; that for the want of manufacturing establishments, nearly every article of consumption that the farm does not produce, is imported from abroad, or from the other States. This state of things necessarily causes a much larger amount of transportation, than in the older States, where the greater variety of pursuits, enables every person to supply most of his wants from the industry of his own neighborhood. The necessary interchange there is effected without going beyond the circuit of a few miles.

"What will be the through travel and business of this road? We may set it down as a fixed fact that the *Central* Road will be completed at an early day. Bloomington, a town about sixty miles northwest from Springfield, is to be a point in this Road. From the latter place, active measures are in progress for the construction of a Railroad to the former. This road will undoubtedly be in readiness as soon as the Central Road is opened to the lake. A line drawn from Chicago to St. Louis, would very nearly pass through the three towns of Alton, Springfield and Bloomington. A road through these intermediate places will constitute the shortest practicable line between the two great Cities of Illinois and Missouri. Travelers from the north, wishing to reach St. Louis on the Mississippi, would leave the Central Road at Bloomington. The Alton and Sangamon Railroad must, therefore, for aught we can see, forever constitute the lower and most profitable part of the *main trunk line,* between Lake Michigan and Springfield, Alton and St. Louis. The latter, we believe, is the great city of the West. In a commercial point of view, the south shore of Lake Michigan is one of the most important points in the United States. It is the ultimate of Lake navigation, and around it sweep all our northern lines of Railroad, running east and west. The through travel must equal, if it does not greatly exceed, the local. We think that no one who will examine a map of Illinois, with the lines of Railroad in progress, can fail to come to similar conclusions.

"The same general conclusions apply with equal force to the transportation of freight. In a good stage of water, the majority of the heavy freight will follow the Canal and the Illinois river. But even at such periods the more valuable and perishable articles will go by Railroad. The same causes which constitute the above the route of travel will make it the route for freight. When the river is not navigable, from low water or ice, the amount of freight thrown upon this road must be very large. A great part of the West will receive their foreign supplies through Chicago, from the low cost of carriage between that city and New York. These goods will be distributed over the country chiefly through Railroad; and from the certainty and

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speed of transportation, St. Louis and Alton will at all times receive no small portion of their merchandise over the above Road.

"We are happy to assure the Stockholders, and the public, that the Road is now making good progress toward Springfield: a large and efficient force is employed at all important points along the line, and it is believed that the whole road will be ready for the rails before the first of May, 1852. Eleven miles of the track is laid, and the iron for the whole road has been purchased, and thirty-three miles of it delivered in Alton, and the balance in New Orleans; 50,000 Cedar cross-ties have also been delivered at Alton, and the balance required for the whole Road are on their way. The Engines and Cars have all been contracted for from the best builders, and a portion of them delivered. The state of the graduation is such that the laying down of the track will be continued without interruption, and in the shortest time, to its entire completion.

"The Directors, influenced by the consideration that the results indicated in the foregoing remarks, will be realized in the completion of their Railroad as a mere local enterprise, and looking to the great accession to their business which may reasonably be expected from the further extension of their Railroad, by a resolution, dated May 30, 1851, directed their Engineer to proceed 'forthwith to make an examination and survey of the Extension of their Railroad from Springfield to Bloomington, with a Branch to Pekin and Peoria.'

* * * * * * *

"COMPARATIVE TABLE

Of Distance and Time, by River and Railroad, taking the Rivers at their best stage, and rate of travel on Railroad, at 25 miles the hour, allowing two hours time, and 20 miles distance, for the Ferry between St. Louis *and* Alton.

Names of Places.	Distance. [miles.]		Time. [hours.]		Difference.	
From—St. Louis—to	River.	R. Road.	River.	R. Road.	In distance.	In time.
Burlington	230	203	30	10	27	20
Oquawka	247	200	30	10	47	22
Rock Island	318	301	40	14	17	26
Galena	408	328	50	15	80	35
Peoria	203	157	26	8	46	18
La Salle	267	211	34	10½	56	23½
Springfield, by River and S. & M. R. R.	161	92	24	5	69	19
Jacksonville	128	125	20	9	3	11

* * * * * * *

"The estimates are predicated on a road-way in excavation of twenty feet, and on embankment of fifteen feet width, with slopes of one and a half to one.

"The estimate for bridges are based on the cost of an iron bridge, on the plan of that across the Canal Basin at Albany, built by S. Whipple, Esq., of Utica. The great scarcity, and consequent cost of timber for such structures, renders it more particularly desirable that Railroads

Mr. Hammond. should dispense with the use of timber, as far as practicable, in the West; and my opinion is, that a proper regard to the true interest of Railway proprietors, should induce Engineers to urge this point.

"I am aware that there is a prejudice in the minds of many distinguished Engineers against the use of iron for bridges, owing to a supposed uncertainty which is stated to exist, as to the strength of the material used. Experience has shown that no subject, in the range of Civil Engineering, has so much exercised the ingenuity and so often disappointed the expectation of the Engineer, as the construction and maintenance of Bridges. Indeed, I believe it may be said of Railroads generally, that all their bridges have been in the first instance too slightly built. Universally on the Pennsylvania works, the older plans have been abandoned to give place to new structures; and on the New York and Erie Railroad, the same process is now going on. Nor are these works exceptions. These structures, for the most part, are of wood, and in view of the above facts, I feel bound to say that I can perceive no objection growing out of the use of iron for bridges, which is not equally applicable to the use of timber. Suitable tests are in use by which the strength of iron may be fully and certainly ascertained; and it cannot be denied, that in durability, accidents from fire, and security from malicious designs, they are far superior to any structure of wood which can be devised.

"With respect to this particular enterprise, I believe that a permanent, indestructible iron bridge may be obtained at a cost not exceeding that of a wooden structure, of the most improved construction. I have accordingly provided in the estimates for iron bridges.

"The scarcity of good timber for the superstructure, and the cost of Oak ties of suitable quality is such, that I have estimated for a superstructure with Cedar cross-ties, ten inches broad, six inches thick, and eight feet long.

"The iron is of the H form, 56 pounds to the yard linear, laid upon ties 30 inches from centre to centre, without juncture plates.

"The depots, engine houses, car houses and shops, water stations, turn-tables, &c., are similar to those on the Michigan Central, and to compare in style with those already erected on this Road.

ESTIMATE:

Graduation and masonry, including bridges, grading of side-tracks, depots, &c., complete from Springfield to Bloomington		$310,567 75
19,200 rods fencing, at 75 cents per yard		14,400 00

SUPERSTRUCTURE.

2,112 cross-ties of Cedar, at 60 cts.	$1,267 20	
88 tons Iron, at $50 per ton,	4,400 00	
4,500 lbs. Spikes, at 6 cents,	270 00	
Workmanship, per mile,	500 00	
62 miles track, including sideings, at	$6,437 20	$399,106 40
Engine, car, and depot houses, and fixtures, at Bloomington		15,000 00
Machine shop and intermediate water stations, &c.		10,000 00
	[Carried over]	$749,074 15

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[Brought over]		$749,074 15
Engineering and contingencies		50,925 85
59 32-100 miles at $13,486 18 per mile, is		800,000 00
Graduation, masonry and bridging, grading depots and side-tracks, of Pekin and Peoria branch	$321,942 72	
Fencing 12,800 rods, at 75 cents	9,600 00	
SUPERSTRUCTURE.		
42 miles track, including sideings, at $6,437 20 per mile, is	270,362 40	
Engine, car, and depot houses and fixtures, at Pekin, and Peoria, and intermediate stations	15,000 00	
		616,905 12
Engineering and contingencies		33,094 88
		$1,450,000 00

Furniture and equipments, will be required, as follows:

5 Engines	at $7,500	$36,500 00	
5 Passenger Cars	at 2,000; 56 seats,	10,000 00	
25 Covered "	at 750	18,750 00	
50 Open Freight Cars,	650	37,500 00	
50 Cattle and Hog Cars,	650	37,500 00	
			140,250 00
Total			$1,590,250 00

"I have made no estimate of the cost of right of way. In most instances, where the land is under cultivation, the right of way will be given if the fencing is provided for, which is an item I have estimated. Where it is uninclosed the present price per acre will range from five to ten dollars.

"In reference to the general results shown in the above estimate, I remark that the average cost per mile a little exceeds the work on the line between Alton and Springfield, owing to the crossing of Salt creek, Sangamon and Mackinaw rivers; but the aggregate, when compared with any hundred miles of Railroad line in the East, indicates very strongly the fact, that while the resources of the country very far exceed any portions of the North and East, the cost of construction is at least sixty per cent. less.

"In conclusion, I have thought it would be desirable to place before our Stockholders, a brief view of the various roads under construction or in contemplation, which will exercise an influence on the prosperity of the State, and necessarily upon that of our Roads. So far as competition may or does exist, I consider it salutary and tending to the prosperity of all the different corporations, who will be impelled by it to do better service to the public, and thus secure more permanently their own interests, than they otherwise would be induced to do. And it is certain that such rivalship though salutary, must exert itself more in appearance than in fact, for the natural increase of business and wealth growing out of the construction and operation

Mr. Hammond. of these Roads, together with the increase of population, will, by adding to the general prosperity, benefit the whole.

"On reference to the outline map herewith, it will be perceived that at Springfield we connect with the Sangamon and Morgan Railroad, which has for several years been in active and profitable operation, a distance of fifty-seven miles. In addition to the local business from Springfield, I think we may look for a large business from the thriving farmers along the line of that Road, as well as from the beautiful and populous village of Jacksonville, and its vicinity. The surplus products of the country are determined north or south as the market rules. For a southern market they would find it for their interest to send over our Road to Alton and St. Louis, and for a northern market by our Road to Bloomington, and thence by Central Railroad and Rock Island Railroad to Chicago; freights in return would take the same course, and we should contribute as much to the business of that Road, if not more, than they would obtain otherwise. At the western end of the Sangamon and Morgan Road, the extension towards Quincy is under contract for some thirty miles; and its early completion may be expected. Eastward, from Springfield, following the old line of the Northern Cross Railroad, arrangements are in progress to enable a connexion to be made with the Central Railroad at some convenient point. I feel quite certain that this design will be carried out; and I doubt not we shall receive a large addition to our business from it. It seems to me, that so far as the course of business will be affected by the opening of our Road to Springfield, that it will reverse the direction of the business on the Sangamon and Morgan Railroad, so that the balance of the business will tend towards Springfield, instead of the Illinois. Among other reasons for this belief, it may be remembered that the time from Springfield to St. Louis is now by Railroad and steamboat twenty-four hours; on the opening of our Road it will not exceed five hours. If then the Sangamon and Morgan Railroad should carry their passengers for nothing, they would still have nineteen hours time against them. In reference to freights also, the prices from Springfield will not exceed the river freights from Naples; shippers will therefore prefer to ship to Springfield rather than to Naples, saving thereby time and insurance. Under these circumstances it is not too much to expect that the business of the country, so far as these two Roads are concerned, will be conducted on fair and equitable conditions. The value of this connexion, by which the lime, coals, lumber and merchandise from the south, may be distributed for sixty miles on each side, is certainly very great.

"From Springfield to Bloomington, the local business will be sufficient to maintain the Road very shortly. The distance from Alton to Galena by this route is 307.68 miles; or in time, thirteen hours. At La Salle, the connexion with the Rock Island Road, extending to Rock Island on the one hand, and Chicago on the other, to the Central Michigan Road, shows how nearly we occupy a position on the great main line of transit.

"Following our line to Pekin and Peoria, we find the only crossing on the Illinois by a bridge; and having crossed it, we unite with the Peoria, Burlington and Oquawka Railroad, through the center of the Military Tract, one of the richest and most thickly settled portions of

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Illinois. In addition to this, following the line of the Illinois river northward, we command the business on both sides of this river for sixty miles. I hesitate not to say this, because we are nearer to St. Louis by forty-three miles in distance and fifteen hours in time, than by the river in the best stage. The average charge for freight will be less than steamboat rates, one season with another. This is a matter which is susceptible of demonstration. Omitting, therefore, all the lines which may be said indirectly to connect with us, we may consider the connexions formed by our extended line as equal to six hundred and sixty-three miles. If, then, the reasoning in the prefatory remarks to this report are reliable, every foot of this extended line will be fully and profitably engaged, and the main branches, where the trade will concentrate, will be compelled to make arrangements for the transaction of a business unparalleled for its importance and extent in the history of commerce.

"The present population of the Counties traversed and touched by the Alton and Sangamon Railroad, and extensions to Bloomington and Peoria, is one hundred and forty thousand; and when it is considered that St. Louis, with her eighty thousand inhabitants, and upwards, is only separated from one end of the Road by a short ferry, and that the Peoria and Oquawka Railroad is an extension of the Peoria Branch, it will be seen that a larger population are directly reached and accommodated than by any Road of the same length in the West.

"The talented and efficient Editors of the Western Journal, and of other papers in St. Louis, have been urging on the capitalists and merchants of that city, the imperative necessity which exists, that every exertion should be made to control the business which seems likely before long to leave its usual course, and flow in another direction. The clearing out of the Rapids on the one hand, and the Shoals at the mouth of the Mississippi on the other, is both useful and necessary; but the influence St. Louis should exert, is to be displayed by opening the most direct, cheap, and speedy routes to their great centre of business and population. How then can this be done with Peoria, Burlington, La Salle, Rock Island, Galena and Chicago? To my mind there is but one answer, and that is to unite in the construction of this line from Springfield north.

"The time required to complete these lines would not exceed two years; and if ample means were provided they might be put in operation sooner. The most careful examination seems only to add force to the conviction, that there is no project now before the public, which will so well remunerate those who may invest their capital in the stock, or from which a larger dividend may be expected.

"I take pleasure in acknowledging my obligations to P. A. Badeau, Principal Assistant, and R. R. Powell and T. Connelly, Junior Assistants, for the efficiency of their services in the field and office.

"Respectfully submitted,

"J. I. SHIPMAN,
"Chief Engineer.

"*To the* President and Directors
of the Alton and Sangamon Railroad Company,
"Alton, *January,* 1852."

Mr. Hammond. The map, referred to by Mr. Shipman, and annexed to his report, shows the railroads built and building in Illinois in 1851, and includes the entire State of Illinois, which may not improperly be termed the heart of the American railroad world, as we know it. The map shows that only the following railroads were built and building at that date:

Galena and Chicago Railroad, 183 miles;
Rock Island Railroad—Rock Island to La Salle—80 miles;
La Salle to Chicago, mileage not given;
Burlington and Peoria Railroad, 92 miles;
Sangamon and Morgan Railroad, from Quincy on the Mississippi River to Meredosia, 60 miles; and thence to Springfield, 55 miles;—115 miles in all. (Of this road, Mr. Shipman was also Chief Engineer.)
Alton and Sangamon Railroad, from Alton to Springfield, 72 miles.

Numerous projected railroads are shown, and the "National Road," crossing the State from Terre Haute to Alton, the famous old wagon road of the pioneers, over which passed the "prairie schooners" from the east to the California gold fields in 1849, which migration was still at its height when Mr. Shipman wrote his report.

The map also shows a small portion of the Michigan Central Railroad, entering Chicago, and a portion of the Hannibal and St. Joseph Railroad, leading out of Hannibal. Only one railroad is shown leading out of St. Louis, and this is named the Pacific Railroad.

Mr. Shipman returned east in 1855, leaving his assistant, Mr. Floyd-Jones, to become Chief Engineer in his place on the construction of the railroad from Bloomington toward Chicago. After his return east, he again became Chief Engineer of the Long Island Railroad, and, as such, constructed nearly all its numerous branches. He died in 1884. In his youth he began his professional career about the year 1834 under Major W. G. McNeil (whom he succeeded as Chief Engineer) on the Brooklyn and Jamaica portion of the Long Island Railroad, and during this early period, the writer is informed, the late James Pugh Kirkwood, M. Am. Soc. C. E., afterward President of this Society, was his assistant. He retired from active professional work several years previous to his death, mainly in consequence of almost complete loss of hearing.

The writer desires to obtain all possible data relative to Mr. Shipman, and will be greatly obliged for corrections and additions to the foregoing.

206 William P. Morse

PROCEEDINGS

OF THE

AMERICAN SOCIETY

OF

CIVIL ENGINEERS

VOL. XXXVII—No. 9

November, 1911

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PROCEEDINGS

OF THE

AMERICAN SOCIETY

OF

CIVIL ENGINEERS

(INSTITUTED 1852)

VOL. XXXVII—No. 9
NOVEMBER, 1911

Edited by the Secretary, under the direction of the Committee on Publications.

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the full title of Paper, name of Author, page reference, and date
of presentation to the Society, are given.

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NEW YORK 1911

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American Society of Civil Engineers

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ON ENGINEERING EDUCATION: Desmond FitzGerald, Benjamin M. Harrod, Onward Bates, D. W. Mead.

ON STEEL COLUMNS AND STRUTS: Austin L. Bowman, Alfred P. Boller, Emil Gerber, Charles F. Loweth, Ralph Modjeski, Frank C. Osborn, George H. Pegram, Lewis D. Rights, George F. Swain, Emil Swensson, Joseph R. Worcester.

ON BITUMINOUS MATERIALS FOR ROAD CONSTRUCTION: W. W. Crosby, A. W. Dean, H. K. Bishop, A. H. Blanchard.

◆

The House of the Society is open from 9 A. M. to 10 P. M. every day, except Sundays, Fourth of July, Thanksgiving Day, and Christmas Day.

HOUSE OF THE SOCIETY—220 WEST FIFTY-SEVENTH STREET, NEW YORK.

TELEPHONE NUMBER.................5913 Columbus.
CABLE ADDRESS....... ...."Ceas, New York."

Vol. XXXVII. NOVEMBER, 1911. No. 9.

AMERICAN SOCIETY OF CIVIL ENGINEERS

INSTITUTED 1852

PROCEEDINGS

This Society is not responsible for any statement made or opinion expressed in its publications.

SOCIETY AFFAIRS

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MINUTES OF MEETINGS

OF THE SOCIETY

October 18th, 1911.—The meeting was called to order at 8.30 P. M.; Rudolph Hering, M. Am. Soc. C. E., in the chair; Chas. Warren Hunt, Secretary; and present, also, 133 members and 20 guests.

A paper by George Gibbs, M. Am. Soc. C. E., entitled "The New York Tunnel Extension of the Pennsylvania Railroad: Station Construction, Road, Track, Yard Equipment, Electric Traction, and Locomotives," was presented by E. R. Hill, M. Am. Soc. C. E., who illustrated his remarks with lantern slides.

A written communication on the subject by J. V. Davies, M. Am. Soc. C. E., was presented by George D. Snyder, M. Am. Soc. C. E., and illustrated with lantern slides.

The Secretary presented written communications on the subject by Messrs. W. J. Wilgus, Charles S. Churchill, and G. R. Henderson, and the paper was discussed orally by Messrs. George B. Francis, Edwin B. Katte, N. W. Storer, and F. J. Sprague.

The Secretary announced the following deaths:

Benjamin Franklin Mackall, elected Member, March 6th, 1901; died April 5th, 1911.

Walter Herbert Sears, elected Member, October 5th, 1904; died October 7th, 1911.

Adjourned.

November 1st, 1911.—The meeting was called to order at 8.30 P. M.; James Owen, M. Am. Soc. C. E., in the chair; Chas. Warren Hunt, Secretary; and present, also, 135 members and 27 guests.

The minutes of the meetings of September 20th and October 4th, 1911, were approved as printed in *Proceedings* for October, 1911.

A paper by Logan Waller Page, M. Am. Soc. C. E., entitled "Some of the Properties of Oil-Mixed Portland Cement Mortar and Concrete," was presented by A. T. Goldbeck, Esq. The Secretary read communications on the subject from Messrs. S. D. Newton, T. S. Oxholm, Lars R. Jorgensen, H. de B. Parsons, and Frank J. Phelan, and the paper was discussed orally by Messrs. D. E. McComb, W. F. Dunham, E. Kuichling, R. S. Buck, Clifford Richardson, E. H. Thomes, R. D. Coombs, and A. T. Goldbeck.

A paper on the "Reinforced Concrete Bridge Across the Almendares River, Havana, Cuba," by Eugene Klapp and W. J. Douglas, Members, Am. Soc. C. E., was presented by Mr. Douglas and illustrated with lantern slides.

The Secretary presented a communication on the subject by L. J. Mensch, M. Am. Soc. C. E., and the paper was discussed orally by Messrs. W. B. Parsons, D. E. McComb, and F. Auryansen.

The Secretary announced the election of the following candidates on October 31st, 1911:

As Members.

Charles Kyes Allen, Portland, Ore.
John Pierce Churchill, East Orange, N. J.
Melville Dozier, Jr., Sacramento, Cal.
Robert Arnold Foster, Lewiston, Idaho.
Orlando Whitney Norcross, Worcester, Mass.

As Associate Members.

Donald Minor Belcher, Wilkes-Barre, Pa.
Herman Claude Berry, Philadelphia, Pa.
Elliot Chipman Brown, New York City.
Roy Huntley Brown, Madison, Me.
James Morgan Clack, Nevada, Mo.
John Edward Bartholomew Dahlin, Edison, Ill.

Aldrich Durant, Havana, Cuba.
Franklin Lincoln Gibboney, Roanoke, Va.
James Nickerson Gladding, Albuquerque, N. Mex.
Roy Cotsworth Gowdy, Fort Worth, Tex.
Edwin Oscar Greifenhagen, Chicago, Ill.
Victor Frank Hammel, New York City.
Lester Clark Hammond, Oyster Bay, N. Y.
Roy Bagley Hayes, Danville, Ky.
Joe Benton High, Brunswick, Ga.
Neil Cummings Holdredge, New York City.
Lucius Sanford Hulburd, Seneca Falls, N. Y.
William Nelson Jones, Minneapolis, Minn.
Clarence Erwin Langley, Gatun, Canal Zone, Panama.
Charles Avery Lee, Vancouver, B. C., Canada.
Harry L McDonald, Sacramento, Cal.
Harry Deyoe McGlashan, San Francisco, Cal.
Leon Lincoln Morton, Texarkana, Tex.
Charles Abraham Park, Detroit, Mich.
Otto Wallace Peterson, Lone Pine, Cal.
Joshua Fielden Ramsbotham, Freemantle, Western Australia.
Fred Morse Randlett, Portland, Ore.
Arthur Leslie Stevens, Cleveland, Ohio.
Chester Arthur Studwell, Port Chester, N. Y.
Charles Harry Tisdale, Guild, Tenn.
Santiago Vilar y Boy, Guatemala, Guatemala.
Joseph Palmer Wadhams, New Haven, Conn.
Jackson Franklin Witt, Dallas, Tex.
Albert Harrison Worley, Kansas City, Mo.
Morris Ernest Zipser, Poughkeepsie, N. Y.

As Associate.

Burton Garfield Philbrick, Oakland, Cal.

As Juniors.

Henry Raymond Angwin, Oakland, Cal.
Harold William Bloemker, Philadelphia, Pa.
Carl Donald Bossert, Washingtonville, Ohio.
William Brooks Clift, Wallsend, Ky.
Ernest Delavan Cole, Coalinga, Cal.
Emil Frank Cykler, Berkeley, Cal.
Earl Raymond Donle, Providence, R. I.
Edwin Arthur Dow, Iowa City, Iowa.
Walter Hanna Dunlap, Jenkins, Ky.
John North Edy, Billings, Mont.

FREDERICK SHELTON FOULKROD, Edgewood Park, Pa.
HENRY JAMES GARDNER, JR., Buffalo, N. Y.
ARTHUR CARL GRIEWANK, San Francisco, Cal.
ISAAC HAUSMAN, Millwood, N. Y.
RALPH FRANCIS HEALY, Pittsburg, Pa.
WILLIAM HENRY JONES, Outlook, Sask., Canada.
LOUIS WILLIAM KLINGNER, Perth, Ont., Canada.
CLAUDE ALFRED LATIMER, New York City.
ERNEST BENJAMIN NELSON, Cristobal, Canal Zone, Panama.
WILLIAM CHRISTIAN REUKAUF, Brooklyn, N. Y.
ROSWELL MORTON ROPER, East Orange, N. J.
HOMER JENNER WILKINS, Oklahoma City, Okla.
WALTER FERRELL WINTON, Nashville, Tenn.

The Secretary announced the transfer of the following candidates on October 31st, 1911:

FROM ASSOCIATE MEMBER TO MEMBER.

THOMAS CLARK ATWOOD, New York City.
HYOTARO INAGAKI, Tokyo, Japan.
CHARLES JOSEPH McGONIGLE, Portland, Ore.
ROBERT ALLEN PENDERGRASS, Pittsburg, Pa.
JAMES WALLACE TOWER, New York City.
ROBERT SPURR WESTON, Boston, Mass.
CHARLES SUMNER WILLIAMSON, Chicago, Ill.

FROM JUNIOR TO ASSOCIATE MEMBER.

LUDLOW OSMOND BARKER, JR., New Cumberland, W. Va.
LYMAN EDGAR BISHOP, Albany, Wyo.
WILLIAM EARL ELAM, Greenville, Miss.
LLOYD WOOLSEY GREENE, Oswego, N. Y.
ORLANDO WILLIAM IRWIN, Detroit, Mich.
FRANK SNOW PARRIGIN, Gainesville, Fla.
CHARLES JUDSON PATERSON, Cleveland, Ohio.
DAVID ELLIOTT PENDLETON, Ennis, Tex.
GEORGE JOHNSON WALKER, Pittsburg, Pa.

The Secretary announced the following death:

GEORGE JOSEPH BELL, elected Associate Member, November 2d, 1898; Member, October 1st, 1902; died October 6th, 1911.

Adjourned.

OF THE BOARD OF DIRECTION

(Abstract)

October 31st, 1911.—President Endicott in the chair; Chas. Warren Hunt, Secretary; and present, also, Messrs. Boller, Flad, Kimball, Loomis, Loweth, Macdonald, Ridgway, Snow, Stott, Talbot, and Thompson.

The President was authorized to appoint a representative of this Society to attend the Sixth Congress of the International Association for Testing Materials, to be held in New York, September 3d, 1912.

The resignation of George Benjamin Lorenz as an Associate Member was accepted.

Ballots for membership were canvassed, resulting in the election of 5 Members, 35 Associate Members, 1 Associate, and 23 Juniors, and the transfer of 9 Juniors to the grade of Associate Member.

Seven Associate Members were transferred to the grade of Member.

Applications were considered, and other routine business transacted.

Adjourned.

ANNOUNCEMENTS

The House of the Society is open from 9 A. M. to 10 P. M., every day, except Sundays, Fourth of July, Thanksgiving Day, and Christmas Day.

FUTURE MEETINGS

December 6th, 1911.—8.30 P. M.—This will be a regular business meeting. Two papers will be presented for discussion: "Experiments on the Flow of Water in Wood Stave Pipes," by E. A. Moritz, Assoc. M. Am. Soc. C. E., and "The St. Croix River Bridge," by C. A. P. Turner, M. Am. Soc. C. E.

These papers were printed in *Proceedings* for October, 1911.

December 20th, 1911.—8.30 P. M.—At this meeting three papers will be presented for discussion, as follows: "Construction of the Morena Rock Fill Dam, San Diego County, California," by M. M. O'Shaughnessy, M. Am. Soc. C. E.; "The Halligan Dam: A Reinforced Masonry Structure," by G. N. Houston, M. Am. Soc. C. E.; and "Provision for Uplift and Ice Pressure in Designing Masonry Dams," by C. L. Harrison, M. Am. Soc. C. E.

The papers by Messrs. O'Shaughnessy and Houston were printed in *Proceedings* for October, 1911, and that by Mr. Harrison appears in this number of *Proceedings*.

January 3d, 1912.—8.30 P. M.—A regular business meeting will be held, and a paper by Henry C. Ripley, M. Am. Soc. C. E., entitled "How to Build a Stone Jetty on a Sand Bottom in the Open Sea," will be presented for discussion.

This paper is printed in this number of *Proceedings*.

ANNUAL MEETING

The Fifty-ninth Annual Meeting will be held at the Society House, on Wednesday and Thursday, January 17th and 18th, 1912. The Business Meeting will be called to order at 10 o'clock on Wednesday morning. The Annual Reports will be presented, officers for the ensuing year elected, members of the Nominating Committee appointed, Reports of Special Committees presented for discussion, and other business transacted.

SPECIAL MEETINGS FOR TOPICAL DISCUSSION

On the two days immediately following the Annual Meeting three meetings of the Society will be held at which the subject for discussion will be "Road Construction and Maintenance."

The meetings will be held as follows:

First Meeting, Friday, January 19th, 1912.—10 A. M.—Two sub-divisions of the subject will be discussed.

(1) "Drainage and Foundations."

The discussion on this topic will be introduced by James Owen, M. Am. Soc. C. E.

(2) "Fillers for Brick and Block Pavements."

The opening discussion on this topic will be by George W. Tillson, M. Am. Soc. C. E.

Second Meeting, Friday, January 19th.—2 P. M.—The following sub-division of the subject will be discussed:

(3) "Bituminous Surfaces."

This topic will be introduced by A. W. Dean, M. Am. Soc. C. E.

Third Meeting, Saturday, January 20th.—10 A. M.—The following sub-division of the subject will be discussed:

(4) "Use of Bituminous Material in Penetration and Mixing Methods."

The discussion on this topic will be introduced by Linn White, Esq.

All Engineers, whether members of the Society or not, are cordially invited to attend these meetings, and it is hoped that the resulting discussion, when collated and published, will bring the whole subject up to date.

SEARCHES IN THE LIBRARY

In January, 1902, the Secretary was authorized to make searches in the Library, upon request, and to charge therefor the actual cost to the Society for the extra work required. Since that time many searches have been made, and bibliographies and other information on special subjects furnished.

The resulting satisfaction, to the members, who have made use of the resources of the Society in this manner, has been expressed frequently, and leaves little doubt that, if it were generally known to the membership that such work would be undertaken, many would avail themselves of it.

The cost is trifling compared with the value of the time of an engineer who looks up such matters himself, and the work can be performed quite as well, and much more quickly, by persons familiar with the Library.

In asking that such work be undertaken, members should specify clearly the subject to be covered, and whether references to general books only are desired, or whether a complete bibliography, involving search through periodical literature, is desired.

In reference to this work, the Appendices* to the Annual Reports of the Board of Direction for the years ending December 31st, 1906, and December 31st, 1910, contain summaries of all searches made to date.

**Proceedings*, Vol. XXXIII, p. 20 (January, 1907); Vol. XXXVII, p. 28 (January, 1911).

PAPERS AND DISCUSSIONS

Members and others who take part in the oral discussions of the papers presented are urged to revise their remarks promptly. Written communications from those who cannot attend the meetings should be sent in at the earliest possible date after the issue of a paper in *Proceedings*.

All papers accepted by the Publication Committee are classified by the Committee with respect to their availability for discussion at meetings.

Papers which, from their general nature, appear to be of a character suitable for oral discussion, will be published as heretofore in *Proceedings,* and set down for presentation to a future meeting of the Society, and, on these, oral discussions, as well as written communications, will be solicited.

All papers which do not come under this heading, that is to say, those which, from their mathematical or technical nature, in the opinion of the Committee, are not adapted to oral discussion, will not be scheduled for presentation to any meeting. Such papers will be published in *Proceedings* in the same manner as those which are to be presented at meetings, but written discussions, only, will be requested for subsequent publication in *Proceedings* and with the paper in the volumes of *Transactions.*

LOCAL ASSOCIATIONS OF MEMBERS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS

San Francisco Association

The San Francisco Association of Members of the American Society of Civil Engineers holds regular bi-monthly meetings, with banquet, and weekly informal luncheons. The former are held at 6 P. M., at the Palace Hotel, on the third Friday of February, April, June, August, October, and December, the last being the Annual Meeting of the Association.

Informal luncheons are held at 12.15 P. M. every Wednesday, and the place of meeting may be ascertained by communicating with the Secretary of the Association, E. T. Thurston, Jr., M. Am. Soc. C. E., 713 Mechanics' Institute, 57 Post Street.

The by-laws of the Association provide for the extension of hospitality to any member of the Society who may be temporarily in San Francisco, and any such member will be gladly welcomed as a guest.

(Abstract of Minutes of Meeting)

October 20th, 1911.—The meeting was called to order; President Derleth in the chair; E. T. Thurston, Jr., Secretary; and present, also, 79 members and guests.

An illustrated lecture on "The Irrigation Developments on the Lower Colorado River, with Their Allied Problems," was delivered by H. T. Cory, M. Am. Soc. C. E., and the subject was discussed by Messrs. C. E. Grunsky and F. C. Herrmann.

Adjourned.

Colorado Association

The meetings of the Colorado Association of Members of the American Society of Civil Engineers are held on the second Saturday of each month, except July and August. The hour and place of meeting are not fixed, but this information will be furnished on application to the Secretary, Gavin N. Houston, M. Am. Soc. C. E., 409 Equitable Building, Denver, Colo. The meetings are usually preceded by an informal dinner. Members of the American Society of Civil Engineers will be welcomed at these meetings.

Weekly luncheons are held on Wednesdays, and until further notice, will take place at the Colorado Traffic Club.

Visiting members are urged to attend the meetings and luncheons.

(Abstract of Minutes of Meeting)

October 14th, 1911.—The meeting was called to order; President Anderson in the chair; G. N. Houston, Secretary; and present, also, 6 members and 2 guests.

The paper entitled "Economic Canal Location in Uniform Countries," by Lyman E. Bishop, Jun. Am. Soc. C. E., was discussed by Messrs. C. C. Williams, Sam G. Porter, and others.

Adjourned.

PRIVILEGES OF ENGINEERING SOCIETIES EXTENDED TO MEMBERS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS

Members of the American Society of Civil Engineers will be welcomed by the following Engineering Societies, both to the use of their Reading Rooms and at all Meetings:

American Institute of Mining Engineers, 29 West Thirty-ninth Street, New York City.

American Society of Mechanical Engineers, 29 West Thirty-ninth Street, New York City.

Architekten-Verein zu Berlin, Wilhelmstrasse 92, Berlin W. 66, Germany.

Associação dos Engenheiros Civis Portuguezes, Lisbon, Portugal.

Australasian Institute of Mining Engineers, Melbourne, Victoria, Australia.

Boston Society of Civil Engineers, 715 Tremont Temple, Boston, Mass.

Brooklyn Engineers' Club, 117 Remsen Street, Brooklyn, N. Y.

Canadian Society of Civil Engineers, 413 Dorchester Street, West, Montreal, Que., Canada.

Civil Engineers' Society of St. Paul, St. Paul, Minn.

Cleveland Engineering Society, Chamber of Commerce Building, Cleveland, Ohio.

Cleveland Institute of Engineers, Middlesbrough, England.

Dansk Ingeniorforening, Amaliegade 38, Copenhagen, Denmark.

Engineers' and Architects' Club of Louisville, Ky., 303 Norton Building, Fourth and Jefferson Streets, Louisville, Ky.

Engineers' Club of Baltimore, Baltimore, Md.

Engineers' Club of Minneapolis, 17 South Sixth Street, Minneapolis, Minn.

Engineers' Club of Philadelphia, 1317 Spruce Street, Philadelphia, Pa.

Engineers' Club of St. Louis, 3817 Olive Street, St. Louis, Mo.

Engineers' Club of Toronto, 96 King Street, West, Toronto, Ont., Canada.

Engineers' Society of Northeastern Pennsylvania, 302 Board of Trade Building, Scranton, Pa.

Engineers' Society of Pennsylvania, 219 Market Street, Harrisburg, Pa.

Engineers' Society of Western Pennsylvania, 2511 Oliver Building, Pittsburg, Pa.

Institute of Marine Engineers, 58 Romford Road, Stratford, London, E., England.

Institution of Engineers of the River Plate, Buenos Aires, Argentine Republic.

Institute of Naval Architects, 5 Adelphi Terrace, London, W. C., England.

Junior Institution of Engineers, 39 Victoria Street, Westminster, S. W., London, England.

Koninklijk Instituut van Ingenieurs, The Hague, The Netherlands.

Louisiana Engineering Society, 321 Hibernia Bank Building, New Orleans, La.

Memphis Engineering Society, Memphis, Tenn.

Midland Institute of Mining, Civil and Mechanical Engineers, Sheffield, England.

Montana Society of Engineers, Butte, Montana.

North of England Institute of Mining and Mechanical Engineers, Newcastle-upon-Tyne, England.

Oesterreichischer Ingenieur= und Architekten=Verein, Eschenbachgasse 9, Vienna, Austria.

Pacific Northwest Society of Engineers, 803 Central Building, Seattle, Wash.

Rochester Engineering Society, Rochester, N. Y.

Sachsischer Ingenieur- und Architekten-Verein, Dresden, Germany.

Sociedad Colombiana de Ingenieros, Bogota, Colombia.

Sociedad de Ingenieros del Peru, Lima, Peru.

Societe des Ingenieurs Civils de France, 19 Rue Blanche, Paris, France.

Society of Engineers, 17 Victoria Street, Westminster, S. W., London, England.

Svenska Teknologforeningen, Brunkebergstorg 18, Stockholm, Sweden.

Tekniske Forening, Vestre Boulevard 18–1, Copenhagen, Denmark.

Western Society of Engineers, 1737 Monadnock Block, Chicago, Ill.

ACCESSIONS TO THE LIBRARY

(From October 11th to November 6th, 1911)

DONATIONS.*

A MANUAL OF CIVIL ENGINEERING PRACTICE.

Specially Arranged for the Use of Municipal and County Engineers. By F. Noel Taylor. Cloth, $9\frac{1}{4}$ x $6\frac{1}{4}$ in., illus., 12 + 809 pp. London, Charles Griffin & Company, Limited; Philadelphia, J. B. Lippincott Company, 1911. $7.50. (Donated by J. B. Lippincott Company.)

It is stated in the preface that this book is designed to meet the need of young engineers who are preparing to occupy positions as Municipal and County Engineers, Borough Surveyors, etc. It deals, it is stated, with the general practice of municipal engineering work and the theoretical principles involved therein, much of the information having been gathered from the author's practical experience. The author's aim has been to present, in this volume, a compendium of Municipal Engineering, and he hopes that, in many ways, it may supplement Professor Rankine's book on Civil Engineering. Many formulas are included in the text, and the Appendices contain Water-works Regulations, General Conditions of Contract, Syllabus of Examinations, Examples of Cost of Engineering Works, etc. The Contents include such subjects as Design of Structures in Brick, Stone and Reinforced Concrete; Chimneys, Steel Construction, and Mechanical Engineering; Roads, Electric Tramways, Bridges, River Work, and Land Drainage; Hydraulics and Pumping Machinery; Water-works and Sources of Supply; Sewage Disposal, Filtration, and Purification; Sanitation, House Drainage, and Disinfection; Refuse Disposal; and Specifications. The subjects of Gas and Electrical Engineering are stated to have been touched on only as they relate to the duties of the surveyor.

THE THEORY AND PRACTICE OF TECHNICAL WRITING.

By Samuel Chandler Earle. Cloth, $7\frac{1}{2}$ x $5\frac{1}{4}$ in., illus., 7 + 301 pp. New York, The Macmillan Company, 1911. $1.25.

In this book the author offers a study of some of the fundamental problems of technical writing for students and engineers, which, it is stated, are not included in the courses on the subject in schools and which cannot be found in the several text-books now being published. He divides his subject-matter into two parts namely, Part I, in which the theory of technical exposition is considered, and Part II, wherein he discusses the applications of the principles in actual practice under different conditions, and the methods of obtaining the best results in technical writing. Brief examples of technical writing are given in the Appendix, not as models, it is stated, but as illustrations of better or worse ways of solving the problems. The author states that his aim in this book is simply to suggest definitely where the difficulties in technical writing lie and what may be done to overcome them. The Contents are: Introduction; Part I, A Study of the Principles of Logical Structure: Analysis by Means of Synopses; Fundamental Principles; Descriptive Exposition; Narrative Exposition; Directions; Description, Narration, and Directions Combined. Part II, Practical Application of Principles: The Essentials of Logical Structure; Addressing General Readers; Addressing Specialists; The Form of the Final Writing; Methods of Writing. Appendix: Illustrative Examples of Technical Writing; Index.

PROBLEMS IN RAILWAY REGULATION.

By Henry S. Haines, M. Am. Soc. C. E. Cloth, 8 x $5\frac{1}{4}$ in., 7 + 582 pp. New York, The Macmillan Company, 1911. $1.75. (Donated by the Author.)

The preface states that it is the author's purpose, in this book, to follow the course of railway regulation in the United States to the present time, to consider the several ways in which the American railway system has affected the general welfare, and to offer some suggestions as to its future regulation. It includes, it is stated, enough description of past conditions to trace to their origin the ills complained of, and to show the effects of attempts to cure them by governmental regulation, these conditions having been discussed in greater detail in the author's previous works, "Restrictive Railway Legislation" and "Railway Corporations as Public Servants," of which this work is stated to be in a sense a continuation. The Contents are: Introduction; The American Railway System: The Period of Formation; The American Railway System: The Period of Extension; The Period of Reconstruction; The Period of Regulation; Recent Railway Regulation; Problems of Incorporation; Problems in Finance; Problems in Construction; Problems in Operation; Problems in Traffic; Problems in Discrimination; Problems in Rate Making; Problems of Capital and Labor; The Tendency of Government Regulation; Appendices; Index.

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*Unless otherwise specified, books in this list have been donated by the publisher.

"HÜTTE": DES INGENIEURS TASCHENBUCH.

Herausgegeben vom Akademischen Verein Hütte, E. V. 21 Auflage. Cloth, 7¼ x 5 in., illus., 3 v. Berlin, Wilhelm Ernst & Sohn, 1911. 18 Marks.

This edition of the "Hütte" is issued as heretofore in three volumes. Volumes I and II contain material for the mechanical engineer and shipbuilder, and are stated to have been brought up to date by the addition of new chapters and by the revision and enlargement of many of the old ones. In this edition, it has been necessary, owing, it is stated, to the rapid development of engineering work, to issue Volume III separately under the title, "Hütte des Bauingenieurs." This volume is stated to be a complete handbook for building engineers, classified by subject, and to correspond to the handbook for metallurgists issued in 1910. The subject-matter in this volume is also stated to have been revised and many new chapters have been added. In all three volumes each chapter has been compiled by a specialist in the subject discussed. The Contents are: Band I, Mathematik; Mechanik starrer Körper; Mechanik tropfbar flüssiger Körper; Mechanik luftförmiger Körper; Wärme; Festigkeitslehre; Stoffkunde; Maschinenteile; Anhang; Sachverzeichnis des ersten, zweiten und dritten Bandes. Band II, Kraftmaschinen; Arbeitsmaschinen; Schiffbau und Schiffsmachinen; Automobilbau; Beleuchtung; Elektrotechnik. Band III, Hütte des Bauingenieurs: Vermessungskunde; Statik der Baukonstruktionen; Grundbau; Eisenbetonbau; Hochbau; Lüftung und Heizung; Fabrikanlagen; Baumaschinen; Wasserbau; Wasserkraftanlagen; Strassenbau; Städtbau; Wasservesorgung; Städteentwässerung; Eisenbahnwesen; Brückenbau; Sachverzeichnis des ersten, zweiten und dritten Bandes.

RAILWAY RATE THEORIES

Of the Interstate Commerce Commission. By M. B. Hammond. Cloth, 8¾ x 5¾ in., 6 + 200 pp. Cambridge, Harvard University, 1911.

The author's purpose, it is stated, is to evolve a theory of railroad rates from a study of the decisions handed down by the Interstate Commerce Commission from 1887 to 1896, which decisions, he states, appear to offer the best opportunity for such an inductive study applicable to American conditions. By analyzing the Commission's decisions, he has prepared a standard, such as value of commodity, cost of service, etc., by which railway rates may be measured and compared and has endeavored, he states, to show the extent to which the Interstate Commerce Commission has made use of such a standard as a basis for determining the reasonableness of rates. This is followed by a discussion of how these diverse principles can be harmonized, and how their relations to each other can be adjusted so as to make it possible to evolve a complete theory of rate making. The Chapter headings are: Introductory; Commission's Preliminary Statement of the Fundamental Principle of Rate Making; Value of Commodity as a Rate Basis; Cost of Service as a Rate Basis; Distance as a Factor in Rate Making; Natural Advantages of Location; Competition as a Factor in Rate Making; Class and Sectional Interests; Fair Return on Investment; General Summary and Conclusions; Table of Cases Cited.

ROCK DRILLING

With Particular Reference to Open Cut Excavation and Submarine Rock Removal. By Richard T. Dana and W. L. Saunders, Members, Am. Soc. C. E. Data Compiled by Construction Service Company. Cloth, 9 x 6 in., illus., 8 + 319 pp. New York, John Wiley & Sons; London, Chapman & Hall, Limited, 1911. $4.00.

Because of its contribution to the general economy of construction, its effect upon the cost of rock work, and its influence on standard engineering methods, it is stated that the rock drill offers a class of problems which have long deserved a special study and a special treatise. In an effort to place the study of rock drilling on a scientific basis and to establish the "best" and most economic method of using the rock drill for any given condition, the Ingersoll-Rand Company, it is stated, instituted an investigation into the economics of drilling and, in this volume, presents the results to engineers and contractors. Descriptions of drills and the cost of both land and subaqueous drilling are given, together with descriptions of field methods and costs of work done in various parts of the country. The Contents are: Blasting and Explosives; Drilling on Land; Subaqueous Drilling; Subaqueous Drilling by the Platform Method; Hints and Suggestions for Rock Drilling and Blasting; Index.

THE THEORY OF STRUCTURES.

By Charles M. Spofford, M. Am. Soc. C. E. Cloth, 9¼ x 6¼ in., illus., 13 + 411 pp. New York and London, McGraw-Hill Book Company, 1911. $4.00.

The preface states that the purpose of this book is to present in a thorough and logical manner the fundamental theories on which the design of the more important elements of engineering structures is based and to illustrate their application by numerous examples. The subject-matter is stated to be confined almost entirely to the treatment of statically determined structures, and while the theories presented are said to be, for the greater part, only such as have been in common use for many years, the method of treatment frequently differs considerably from that found in other books. The author calls special attention to the early introduction of the influence line and to its use in determining and illustrating analytical methods, as well as to the chapter on Deflections. The Contents are: Outer and Inner Forces; Laws of Statics, Reactions, Shears and Moments, Influence Lines; Concentrated Load Systems; Beam Design; Plate Girder Design; Simple Trusses; Bridge Trusses with Secondary Web Systems, Including the Baltimore and Pettit Trusses; Trusses with Multiple Web Systems, Lateral and Portal Bracing, Transverse Bents, Viaduct Towers; Cantilever Bridges; Three-Hinged Arches; Design of Columns and Tension Members; Pin and Riveted Truss Joints; Graphical Statics; Deflection and Camber; Continuous and Partially Continuous Girders and Swing Bridge Reactions; Index.

FRAMED STRUCTURES AND GIRDERS:

Theory and Practice. By Edgar Marburg, M. Am. Soc. C. E. Vol. I, Stresses, Pt. 1. Cloth, 9½ x 6 in., illus., 21 + 540 pp. New York and London, McGraw-Hill Book Company, 1911. $4.00.

The present volume of this work, which the author states is to appear in three volumes, is devoted mainly to the derivation of the fundamental principles of statics, the determination of shears and bending moments in beams, and the analysis of roof and bridge trusses resting on two supports. The author states that he has used about two-thirds of the subject-matter in his classes, and while the work is designed primarily as a text-book, he hopes it may be found useful for reference as well. The earlier chapters are devoted, it is stated, partly or wholly to a brief but critical consideration of the principles of statics on account of their fundamental importance. In Chapter V are presented the general methods, graphic and algebraic, applicable to the analysis of stresses in framed structures, both roof and bridge trusses being discussed. Chapter VI is devoted exclusively to the bringing out of the important underlying principles of stresses in roof trusses. In the following chapters are presented analyses of stresses in bridge trusses; a brief historical account of bridge building and the evolution of the modern bridge truss, with special reference to American conditions; skew bridges and bridges on curves; stresses in lateral and sway bracing and in viaduct towers; and deformation in trusses, and camber. The Contents are: General Considerations and Definitions; The Equilibrium of Coplanar Forces; Application of the Laws of Equilibrium to the Determination of Reactions; Shears and Bending Moments in Simple Beams; Application of the Laws of Equilibrium to the Determination of Stresses; Roof Trusses; Stresses in Bridge Trusses with Horizontal Chords; Stresses in Bridge Trusses with Inclined Chords; Modern Bridge Trusses and Their Development; Stresses in Bridge Trusses with Sub-Panels; Live-Load Stresses by Graphic Methods—Influence Lines; Skew Bridges and Bridges on Curves; Live Loading for Bridges; Lateral Bracing and Transverse Bracing; Stresses in Viaduct Towers; Deformation of Trusses, Camber; Index.

THE WIDTH AND ARRANGEMENT OF STREETS.

A Study in Town Planning. By Charles Mulford Robinson. Cloth, 9¼ x 6 in., illus., 10 + 199 pp. New York, The Engineering News Publishing Company; London, Archibald Constable & Co., Ltd., 1911. $2.00.

The subject-matter of this book was offered, it is stated, as a general thesis at the International Town Planning Conference held in London in 1910, and is said to contain the results of the author's observations in some thirty towns and cities from the Atlantic Coast to the mid-Pacific, where he studied and diagnosed their special needs as regards the city plan. The book is stated to deal particularly with the attractive development of residential and suburban tracts, and the author has endeavored to state facts as to street platting which should be understood by city officials, the tract developer, the lot buyer, and the tenant. A part of Chapter I and Chapters II, III, and IV are devoted to pointing out defects in the usual present practice of street design and the advantages of a closer adjustment to functions. The remainder of the book contains the constructive suggestions. The Chapter headings are: Main Divisions of a Street System: The Standardizing of Streets; Street Width and Housing; Street Width and Land Values; Main Traffic

Streets; How to Lessen the Cost of Wide Streets; Provision of Central Control; Platting of Minor Residence Streets in High Class Districts; The Development of High Class Minor Streets; The Platting of Minor Streets for Humble Homes; Public Reservations Other Than Streets; Conclusion; Appendix; Index.

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Wisconsin, Univ. of. 1 pam.
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BY PURCHASE.

Practical Hygiene: A Manual for Students, Physicians, and Health Officers. By Charles Harrington. Fourth Edition, Revised and Enlarged by Mark Wyman Richardson. Lea & Febiger, Philadelphia and New York, 1911.

The Corrosion of Iron and Steel. By J. Newton Friend. Longmans, Green and Co., New York and London, 1911.

Themen der Physikalischen Chemie. Von Emil Baur. Akademische Verlagsgesellschaft, m. b. H., Leipzig, 1910.

Drying Machinery and Practice: A Handbook on the Theory and Practice of Drying and Desiccating, with Classified Description of Installations, Machinery, and Apparatus, Including also a Glossary of Technical Terms and Bibliography. By Thomas G. Marlow. D. Van Nostrand Company, New York; Crosby Lockwood and Son, London, 1910.

Power Plant Testing: A Manual for Testing Engines, Turbines, Boilers, Pumps, Refrigerating Machinery, Fans, Fuels, Materials of Construction, etc. By James Ambrose Moyer. McGraw-Hill Book Company, New York and London, 1911.

Electric Traction and Transmission Engineering. By Samuel Sheldon and Erich Hausmann. D. Van Nostrand Company, New York, 1911.

The Production of Malleable Castings: A Practical Treatise on the Processes Involved in the Manufacture of Malleable Cast Iron. By Richard Moldenke. The Penton Publishing Company, Cleveland, Ohio, 1910.

Petroleum Mining and Oil-Field Development: A Guide to the Exploration of Petroleum Lands, and a Study of the Engineering Problems Connected with the Winning of Petroleum, Including Statistical Data of Important Oil-Fields, Notes on the Origin and Distribution of Petroleum, and a Description of the Methods of Utilising Oil and Gas Fuels. By A. Beeby Thompson. D. Van Nostrand Company, New York; Crosby Lockwood and Son, London, 1910.

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(From October 11th to November 6th, 1911)

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Total	361

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BARNES, WILLIAM THOMAS. With Metcalf & Eddy, Room 1824, Harris Trust Bldg., Chicago, Ill	Assoc. M. M.	Sept. 7, 1898 Oct. 3, 1911
BROWN, WILLIAM. Chairman and Managing Director, William Simons & Co., Ltd., 7 Whittingehame Gardens, Kelvinside, Glasgow, Scotland		Oct. 3, 1911
CHRISTIAN, WILLIAM ARNOLD. First Asst. Engr., Chic., Gt. West. R. R., Room 463, Grand Central Station, Chicago, Ill		Oct. 3, 1911
CHURCHILL, JOHN PIERCE. Engr., Hay Foundry & Iron Works, 19 Whittelsey Ave., East Orange, N. J.....		Oct. 31, 1911
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WESTON, ROBERT SPURR. San. Engr., 14 Beacon St., Boston, Mass..............	Assoc. M. M.	Feb. 5, 1902 Oct 31, 1911
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Berry, Herman Claude. Asst. Prof. of Materials of Constr., Civ. Eng. Dept., Univ. of Pennsylvania, Philadelphia, Pa		Oct. 31, 1911
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Cahn, Elias. 103 West 141st St., New York City		June 6, 1911
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Gibboney, Franklin Lincoln. City Engr., Roanoke, Va		Oct. 31, 1911
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Lamson, William Mather. Asst. Engr., Board of Water Supply, 165 Broadway, Room 725, New York City.		Sept. 5, 1911
Lang, Philip George, Jr. Asst. Engr., Bridge Dept., B. & O. R. R., B. & O. Bldg., Baltimore, Md.		Oct. 3, 1911
Mason, Frank Henry. Central Maine Power Co., Main Ave., Gardiner, Me.		Oct. 3, 1911
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Mayell, Albert Jefferson. Asst. Engr., Public Service Comm., First Dist., 154 Nassau St. (Res., 322 East 198th St.), New York City.	Jun. Assoc. M.	Mar. 1, 1904 Oct. 3, 1911
Moncur, George. Prof. of Civ. Eng., Glasgow Technical Coll., Glasgow, Scotland.		June 6, 1911
Morrison, Thomas Edward. 5656 Vernon Ave., St. Louis, Mo.		Oct. 3, 1911
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Pierce, Paul Leon. 909 East 9th St., Chattanooga, Tenn.	Jun. Assoc. M.	Jan. 7, 1908 Oct. 3, 1911
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Studwell, Chester Arthur. Port Chester, N. Y.		Oct. 31, 1911
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ASSOCIATES

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JUNIORS

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DEATHS

BELL, GEORGE JOSEPH. Elected Associate Member, November 2d, 1898; Member, October 1st, 1902; died October 6th, 1911.

MACKALL, BENJAMIN FRANKLIN. Elected Member, March 6th, 1901; died April 5th, 1911.

SEARS, WALTER HERBERT. Elected Member, October 5th, 1904; died October 7th, 1911.

Total Membership of the Society, November 7th, 1911, 6 277.

MONTHLY LIST OF RECENT ENGINEERING ARTICLES OF INTEREST

(October 10th to November 6th, 1911)

NOTE.—*This list is published for the purpose of placing before the members of the Society, the titles of current engineering articles, which can be referred to in any available engineering library, or can be procured by addressing the publication directly, the address and price being given wherever possible.*

LIST OF PUBLICATIONS

In the subjoined list of articles, references are given by the number prefixed to each journal in this list:

(1) *Journal,* Assoc. Eng. Soc., 31 Milk St., Boston, Mass., 30c.
(2) *Proceedings,* Engrs. Club of Phila., 1317 Spruce St., Philadelphia, Pa.
(3) *Journal,* Franklin Inst., Philadelphia, Pa., 50c.
(4) *Journal,* Western Soc. of Engrs., Monadnock Blk., Chicago, Ill.
(5) *Transactions,* Can. Soc. C. E., Montreal, Que., Canada.
(6) *School of Mines Quarterly.* Columbia Univ., New York City, 50c.
(8) *Stevens Institute Indicator,* Stevens Inst., Hoboken, N. J., 50c.
(9) *Engineering Magazine,* New York City, 25c.
(10) *Cassier's Magazine,* New York City, 25c.
(11) *Engineering* (London), W. H. Wiley, New York City, 25c.
(12) *The Engineer* (London), International News Co., New York City, 35c.
(13) *Engineering News,* New York City, 15c.
(14) *The Engineering Record,* New York City, 12c.
(15) *Railway Age Gazette,* New York City, 15c.
(16) *Engineering and Mining Journal,* New York City, 15c.
(17) *Electric Railway Journal,* New York City, 10c.
(18) *Railway and Engineering Review,* Chicago, Ill., 10c.
(19) *Scientific American Supplement,* New York City, 10c.
(20) *Iron Age,* New York City, 10c.
(21) *Railway Engineer,* London, England, 25c.
(22) *Iron and Coal Trades Review,* London, England, 25c.
(23) *Bulletin,* American Iron and Steel Assoc., Philadelphia, Pa.
(24) *American Gas Light Journal,* New York City, 10c.
(25) *American Engineer,* New York City, 20c.
(26) *Electrical Review,* London, England.
(27) *Electrical World,* New York City, 10c.
(28) *Journal,* New England Water-Works Assoc., Boston, Mass., $1.
(29) *Journal,* Royal Society of Arts, London, England, 15c.
(30) *Annales des Travaux Publics de Belgique,* Brussels, Belgium.
(31) *Annales* de l'Assoc. des Ing. Sortis des Ecoles Spéciales de Gand, Brussels, Belgium.
(32) *Mémoires et Compte Rendu des Travaux,* Soc. Ing. Civ. de France, Paris, France.
(33) *Le Génie Civil,* Paris, France.
(34) *Portefeuille Economiques des Machines,* Paris, France.
(35) *Nouvelles Annales de la Construction,* Paris, France.
(37) *Revue de Mécanique,* Paris, France.
(38) *Revue Générale des Chemins de Fer et des Tramways,* Paris, France.
(41) *Modern Machinery,* Chicago, Ill., 10c.
(42) *Proceedings,* Am. Inst. Elec. Engrs., New York City, 50c.
(43) *Annales des Ponts et Chaussées,* Paris, France.
(44) *Journal,* Military Service Institution, Governors Island, New York Harbor, 50c.
(45) *Mines and Minerals,* Scranton, Pa., 20c.
(46) *Scientific American,* New York City, 8c.
(47) *Mechanical Engineer,* Manchester, England.
(48) *Zeitschrift,* Verein Deutscher Ingenieure, Berlin, Germany.
(49) *Zeitschrift für Bauwesen,* Berlin, Germany.
(50) *Stahl und Eisen,* Düsseldorf, Germany.
(51) *Deutsche Bauzeitung,* Berlin, Germany.
(52) *Rigasche Industrie-Zeitung,* Riga, Russia.
(53) *Zeitschrift,* Oesterreichischer Ingenieur und Architekten Verein, Vienna, Austria.
(54) *Transactions,* Am. Soc. C. E., New York City, $4.
(55) *Transactions,* Am. Soc. M. E., New York City, $10.
(56) *Transactions,* Am. Inst. Min. Engrs., New York City, $5.

(57) *Colliery Guardian,* London, England.
(58) *Proceedings,* Engrs.' Soc. W. Pa., 803 Fulton Bldg., Pittsburg, Pa., 50c.
(59) *Transactions,* Mining Inst. of Scotland, London and Newcastle-upon-Tyne, England.
(60) *Municipal Engineering,* Indianapolis, Ind., 25c.
(61) *Proceedings,* Western Railway Club, 225 Dearborn St., Chicago, Ill., 25c.
(62) *Industrial World,* 59 Ninth St., Pittsburg, Pa.
(63) *Minutes of Proceedings,* Inst. C. E., London, England.
(64) *Power,* New York City, 20c.
(65) *Official Proceedings,* New York Railroad Club, Brooklyn, N. Y., 15c.
(66) *Journal of Gas Lighting,* London, England, 15c.
(67) *Cement and Engineering News,* Chicago, Ill., 25c.
(68) *Mining Journal,* London, England.
(70) *Engineering Review,* New York City, 10c.
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(71*a*) *Carnegie Scholarship Memoirs,* Iron and Steel Inst., London, England.
(73) *Electrician,* London, England, 18c.
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(78) *Beton und Eisen,* Vienna, Austria.
(79) *Forscherarbeiten,* Vienna, Austria.
(80) *Tonindustrie Zeitung,* Berlin, Germany.
(81) *Zeitschrift für Architektur und Ingenieurwesen,* Wiesbaden, Germany.
(83) *Progressive Age,* New York City, 15c.
(84) *Le Ciment,* Paris, France.
(85) *Proceedings* Am. Ry. Eng. and M. of W. Assoc., Chicago, Ill.
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(93) *Revue de Métallurgie,* Paris, France, 4 fr. 50.
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(97) *Turbine,* Berlin, Germany. 1 Mark.
(98) *Journal,* Engrs. Soc. Pa., 219 Market St., Harrisburg, Pa., 30c.
(99) *Proceedings,* Am. Soc. of Municipal Improvements, New York City, $1.50.
(100) *Professional Memoirs,* Corps of Engrs., U. S. A., Washington, D. C., $1.
(101) *Metal Worker,* New York City, 10c.
(102) *Organ für die Fortschritte des Eisenbahnwesens,* Wiesbaden, Germany.
(103) *Mining and Scientific Press,* San Francisco, Cal., 10c.
(104) *The Surveyor and Municipal and County Engineer,* London, England, 6d.
(105) *Metallurgical and Chemical Engineering,* New York City, 25c.
(106) *Transactions,* Inst. of Mining Engrs., London, England, 6 shillings.
(107) *Schweizerische Bauzeitung,* Zürich, Switzerland.
(108) *Southern Machinery,* Atlanta, Ga., 10c.

LIST OF ARTICLES.

Bridges.

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The Superstructure of the Passyunk Bridge.* Henry H. Quimby. (2) Oct.
The Coteau Railway Bridge Across the St. Lawrence River, Canada.* Howard G. Kelley. (11) Oct. 6.
A Novel Bridge for Chicago.* (96) Oct. 12.
Demolition of Bridlington Railway Bridge, North Eastern Railway.* (11) Oct. 13.
Recommendation for Draw-Bridges on Main Track. (From paper read before the Ry. Signal Assoc.) (18) Oct. 14.
Rye Outlet Bridge at Kensico Reservoir, Catskill Aqueduct; a Concrete Arch Bridge with Two Arch Rings in Each Span and Transverse Spandrel Walls.* (14) Oct. 14.
Reinforcing the Lateral Systems of the Williamsburg Bridge.* (14) Oct. 21.
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The Queen Street Viaduct.* (96) Oct. 26.
The Railroad Bridge over the Pend Oreille River.* (14) Nov. 4.
Pequest River Double Culvert, Lackawanna Railroad.* A. B. Cohen. (14) Nov. 4.
Contribution à l'Etude des Ponts à Béquille.* L. Descans. (30) Oct.
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Die Hetzersche Holzbauweise.* (107) Oct. 14.
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Electrical.

The Magnetic Properties of Some Manganese Steels of Definite Composition. Ezer Griffiths. (77) Sept.
The Heating of Cables with Current.* S. W. Melsom. (77) Sept.
A Power Company's Testing Department. E. Fawssett. (77) Sept.
The Driving of Winding Engines by Induction Motors.* H. J. S. Heather. (77) Sept.
Automatic Telephone Exchange Systems.* W. Aitken. (77) Sept.
Single-Phase Commutator Motors, Especially the Latour-Winter-Eichberg Type.* G. W. P. Page and G. J. Scott. (77) Sept.
Notes on the Design and Construction of Dry-Core Lead-Covered Telephone Cables.* H. C. May. (77) Sept.
Electrical Plant for Driving the Reversing Rolling-Mill at the Skinningrove Iron Works.* (11) Sept. 29.
The Determination of Synchronous and Asynchronous Reactance.* J. Rezelman. (73) Serial beginning Sept. 29.
Report on Motor-Generators, Converters and Rectifiers. Silvanus P. Thompson. (Paper read before the International Congress of the Applications of Electricity.) (73) Sept. 29; (47) Oct. 6.
A New System for Protecting High-Tension Cables. H. Birrenbach and M. Höchstädter. (Abstract from *Elektrotecknik Zeitschrift.*) (73) Sept. 29.
Notes on a Telephone System Recently Built in San Francisco and its Neighborhood.* Samuel G. McMeen. (4) Oct.
Electrolytic Corrosion of Iron by Direct Current.* J. L. R. Hayden. (3) Oct.
Tramcar Meters.* R. G. Cunliffe and J. G. Cunliffe. (Abstract of paper read before the Conference of the Municipal Tramways Assoc.) (73) Oct. 6.
The Balloon as a Wireless Telegraph Receiving Station.* P. Ludewig. (Abstract from *Physikalische Zeitschrift.*) (73) Oct. 6.
Report of the Committee on Power Generation.* (Abstract of paper read before the Am. Elec. Ry. Eng. Assoc.) (17) Oct. 12.
Rotor Hysteresis in Polyphase Induction Motors.* David Robertson. (73) Oct. 13.
Dry Cell Testing.* W. B. Pritz. (Abstract of paper read before the Am. Electrochemical Soc.) (73) Oct. 13.
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Wireless Telegraph Antennæ, Operating Characteristics of the Umbrella Type of Aerial.* David Darrin. (27) Oct. 14.
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The Electrical Conductivity and Constitution of Alloys.* W. M. Guerther. (Paper read before the Inst. of Metals.) (11) Oct. 20.
Power-Distributing System of the Oakland, Alameda and Berkeley Suburban Lines of the Southern Pacific Company.* (17) Serial beginning Oct. 21.
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Small Isolated Electric Power Plants.* Frederick E. Ward. (46) Oct. 21.
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Modern Designs of Electric Capstans.* (73) Oct. 27.
The Heyland Diagram for Induction Motors and Reverse Current Operation.* H. J. S. Heather. (73) Oct. 27.
A Municipal Hydroelectric Plant at Richmond.* James Purcell. (14) Oct. 28.
The First 110,000 Volt Installation in Europe.* Kurt Perlewitz. (27) Oct. 28.
The Heating of Synchronous Converters.* Nicholas Stahl. (27) Oct. 28.
The Cost of Arc Lighting and General Service from Medium and Small Size Municipal or Private Plants. W. Edgar Reed. (42) Nov.
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Cincinnati's Plum Street Station; Conversion of a Reciprocating Steam Plant to Modern Turbine Equipment.* (27) Nov. 4.

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Automatic Coaling of Ships.* (12) Sept. 29.
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A Steam Launch.* (12) Oct. 20.
Curtis Marine Steam Turbine.* (47) Oct. 20.
Wireless-Controlled Boat.* (19) Oct. 21.
Chain and Rope Towage on German Rivers.* K. Dietze. (95) Serial beginning Nov.
Stern-Wheel Motor Boats.* Lewis C. Allen. (From *The Gas Engine*.) (95) Nov.
Light-Draft Tug *Maria Hendrika III*.* D. Kooijman. (95) Nov.
Mietz & Weiss Oil Engine.* (For motor boat.) (95) Nov.
Fonctionnement des Pompes Centrifuges en Régimes Variable, Application au Calcul des Epuisements de Cales de Radoub. L. Bergeron. (37) Sept. 30.

Mechanical.

The Energy-Diagram for Gas.* F. W. Burstall. (75) Jan.
Exhaust Steam Turbines.* R. C. Plowman and E. F. Hetherington. (77) Sept.
The Corrosion of Brass with Special Reference to Condenser-Tubes.* Paul T. Bruhl. (Paper read before the Inst. of Metals.) (11) Serial beginning Sept. 29; (12) Sept. 29.
Notes on the Design of Impellers of Modern Centrifugal Pumps.* N. W. Akimoff. (2) Oct.
High-Pressure Lighting.* W. B. Farquhar. (Paper read before the Eastern Counties Gas Mgrs. Assoc.) (66) Oct. 3.
The Vigeland Aluminum Works, South Norway.* G. Wüthrich. (12) Serial beginning Oct. 6.
Steam Turbine Tests.* (47) Oct. 6.
High and Low Pressure Distribution Schemes at Tynemouth. F. C. Willis. (Paper read before the North of England Gas Assoc.) (66) Oct. 10.
Gas-Governors. W. Carmichael Peebles. (Paper read before the Scottish Junior Gas Assoc.) (66) Oct. 10.
Coal-Lining at the Cheltenham Gas-Works.* (66) Oct. 10.
High Pressure Gas Distribution. E. W. Smith. (Paper read before the Manchester Univ.) (66) Oct. 10.
Boiler Efficiency of 83.69 Per Cent.* (64) Oct. 10.
A New Drag-Line Scraper Bucket.* (13) Oct. 12.
The Works of the British Welding Company.* (11) Oct. 13.
The Burnley Corporation Gas-Works Extension.* (11) Oct. 13.
Breakdowns of Gas and Oil Engines.* Michael Longridge. (47) Oct. 13.
Direct-Recovery Coke Ovens and Benjol Plant at New Brancepeth Colliery.* (22) Oct. 13.
The Hilger Rotary-Grate Gas Producer.* (22) Oct. 13.
Progress in Aerodynamics.* Grover Cleveland Loening. (46) Oct. 14.
Rates for Gas Service. C. L. Cory. (Paper read before the Pacific Coast Gas Assoc.) (24) Serial beginning Oct. 16; (83) Oct. 16.
The Woodall-Duckham Retort Installation at Lausanne. M. Cornaz. (Abstract from *Le Gaz*.) (66) Oct. 17.
Lubrication and Maintenance Costs; Methods of Lubricating Cranes. T. E. Tynes. (Paper read before the Am. Iron and Steel Elec. Engrs.) (62) Oct. 16.
High Pressure Gas Distribution. C. S. S. Forney. (Paper read before the Pacific Coast Gas Assoc.) (24) Oct. 16.
High Pressure Line at Flushing, N. Y.* (83) Oct. 16.
The Naphthalene Problem in Oil Gas Manufacture and Distribution.* F. S. Wade. (Paper read before the Pacific Coast Gas Assoc.) (83) Oct. 16; (24) Oct. 30.
Mechanical Handling of Carbon By-Product of the Oil Gas Process.* D. J. Young. (Paper read before the Pacific Coast Gas Assoc.) (83) Oct. 16; (24) Oct. 30.
Power Plant of Curtis Publishing Co.* A. D. Blake. (64) Oct. 17.
New Methods of Gas Analysis.* L. Ubbelohde and de Castro and Hohensee. (From *Journal für Gasbeleuchtung*.) (66) Oct. 17.
Thermal and Static Heads and Flow of Heat and Liquids. F. E. Matthews. (64) Oct. 17.
Power Derivable from Ocean Waves.* Franklin Van Winkle. (64) Oct. 17.
The Besly Disk Grinder.* (20) Oct. 19.

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Steamers and Fueling Barges Equipped with Conveying Apparatus for Discharging Cargo.* (13) Oct. 19.
Crane Specifications. Edward G. Fiegehen. (11) Oct. 20.
Wolseley Motor-Cars.* (11) Oct. 20.
Power-Plant Failures. Michael Longridge. (11) Oct. 20.
Steam Engine Breakdowns.* Michael Longridge, M. Inst. C. E. (47) Serial beginning Oct. 20.
A Kansas Natural-Gas Driven Station.* (27) Oct. 21.
A High-Pressure System of Gas Distribution.* Charles Hughes. (14) Oct. 21.
Increasing the Pressure in Gas Mains by Compressors.* (24) Oct. 23.
Unstable Hydrocarbons in Illuminating Gas. E. C. Jones. (Paper read before the Pacific Coast Gas Assoc.) (24) Oct. 23; (83) Oct. 16.
Coal Supply for the Nice Gas-Works.* (66) Oct. 24.
Methods and Cost of Removing Stumps from a Reservoir Site, Morgantown, W. Va.* Victor F. Hammel. (Abstract from *The Contractor.*) (86) Oct. 25.
Foundry of Tractor Works at La Porte.* (20) Oct. 26.
A Mechanically Operated Foundry.* (20) Oct. 26.
New Coal Conveyors on the Humber.* (57) Oct. 27.
Wire Ropeway Plant at the Orconera Iron-Mines, Spain.* (11) Oct. 27.
Vacuum Cleaning Plant in Railroad Yard.* (101) Oct. 27.
New Salt Works in Cheshire.* (12) Oct. 27.
Manufacturing Metal Sheets.* (101) Oct. 27.
Efficiency of Reciprocating Engines.* K. Heilmann. (64) Oct. 31.
Test of an Unusually High Pressure Centrifugal Blower Set.* (70) Nov.
District Holders.* R. G. Griswold. (Paper read before the Am. Gas Inst.) (83) Nov. 1.
Some Principles of Condensation with Especial Reference to Water Gas.* L. E. Worthing. (Paper read before the Am. Gas Inst.) (83) Nov. 1.
Tar and Tar Products.* Alan Dean Whittaker. (Paper read before the Am. Gas Inst.) (83) Nov. 1.
The Upson Nut Company's Steel Plant.* (20) Nov. 2.
Machine Shops of Rumely Tractor Works.* (20) Nov. 2.
The Power Necessary to Drive an Aeroplane.* Sydney V. James. (19) Nov. 4.
The Practical Running of the Locomobile.* Warren H. Miller. (27) Nov. 4.
L'Etat Actuel de la Théorie et de la Pratique de la Cémentation.* Léon Guillet. (33) Serial beginning July 22.
L'Aphégraphe.* R. Guillery. (32) Aug.
Etablissement des Dépots d'Hydrocarbures dans les Garages d'Omnibus Automobiles de la Compagnie Générale des Omnibus de Paris avec Emploi des Appareils du Système Martini et Huneke.* A. Mariage. (32) Aug.
Progrès Réalisés Récemment dans la Récupération et le Traitement des Sous Produits de la Distillation de la Houille. A. Grebel. (33) Serial beginning Sept. 30.
Etude sur l'Amplitude et la Réduction des Pertes Consécutives à la Transformation de l'Energie Calorifique en Energie Mécanique ou Electrique par les Turbines à Vapeur. A.-R. Garnier. (39) Sept. 30.
Compteurs de Vapeur. M. Emanaud. (34) Oct.
Versuche mit Luftpropellern.* (97) April 5.
Neuere Curtis-Schiffsturbinen.* Kraft. (97) June 20.
Die Turbinenfabrikation der A. E. G.* O. Lasche. (48) Serial beginning July 22.
Ueber Führungen an Feineisenwalzwerken.* Fr. Münker. (50) Oct. 5.
Turbogebläse, System Rateau, für die Hochöfen von Vizcaya.* A. Rateau. (53) Oct. 6.
Kerchove- und Gleichstrom-Dampfmaschine.* G. Doederlein. (48) Oct. 7.
Ueber Gasturbinen.* P. Langer. (50) Oct. 19.
Entwicklung und Aussichten des Stahlbandantriebes.* L. Silberberg. (48) Oct. 21.
Messgeräte für Druck und Geschwindigkeit von Gasen und Dämpfen.* Ernst Stach. (50) Serial beginning Oct. 26.
Entschlammung der Waschwässer von der Hochofengasreinigung.* E. Steuer. (50) Oct. 26.

Metallurgical.

The Alloys of Aluminum and Zinc.* Walter Rosenhain. (Paper read before the Inst. of Metals.) (11) Sept. 29.
Some Engineering Features of Electric Furnaces.* Carl Hering. (2) Oct.
The Present Position of Electric Steel Melting. McWilliam. (Paper read before the British Assoc.) (47) Oct. 6.
Microscopic Examination of Iron and Steel.* William Campbell. (From paper read before the Am. Foundrymen's Assoc.) (47) Oct. 6
Electric Tin-Smelting. J. Harden. (22) Oct. 6; (73) Sept. 29.
Progress in the Electrometallurgy of Iron and Steel. Donald F. Campbell. (Abstract of a paper read before the Faraday Soc.) (22) Oct. 13.
The Cupellation of Lead Bullion.* Roy F. Coolidge. (16) Oct. 14.

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Metallurgical—(Continued).

The Electrical Conductivity and Constitution of Alloys.* W. M. Guerther. (Paper read before the Inst. of Metals.) (11) Oct. 20.
The Treatment of Complex Zinc-Lead Ores, and the Bi-Sulphite Process. (68) Oct. 21.
Galvanizing Wire in Zinc-Dust. Alfred Sang. (Abstract from paper read before the Am. Electrochemical Soc.) (96) Oct. 26.
The Electrical Precipitation of Suspended Particles from Smelter Fumes.* F. G. Cottrell. (From *Journal of Industrial and Engineering Chemistry.*) (13) Oct. 26.
Possible Reduction of the Power Consumption in Electric Steel Refining Furnaces.* Carl Hering. (105) Nov.
The Paragon Electric Furnace and Recent Developments in Metallurgy.* Joh. Härden. (Paper read before the Faraday Soc.) (105) Nov.
Treatment of Broken Hill Ores.* W. Poole. (45) Serial beginning Nov.
A Spanish Iron-Ore Treatment Plant.* (45) Nov.
Air-Lift Agitation of Slime Pulp.* E. J. Laschinger. (45) Nov.
Proposed Treatment of Sulphide Ores with Nitric Acid, or So-Called Rankin Process. (105) Nov.
Modern Alloys of Aluminum.* C. A. H. Lantsberry. (Abstract of paper read before the Brit. Foundrymen's Assoc.) (96) Nov. 2.
Four Electrique pour la Fabrication et l'Affinage de l'Acier, Système Nathusius.* Gustave Hinard. (34) Oct.
Ueber die physikalisch-chemischen Grundlagen des Hüttenwesens.* R. Schenck. (50) Oct. 26.
Elektrisches Schweissen.* Bruno Loewenherz. (48) Oct. 7.

Military.

Dropping Bombs from Flying Machines.* Riley E. Scott. (46) Oct. 28.
The Necessity and Use of Electrical Communications on the Battle-field.* E. D. Peek. (44) Nov.
Telegraph Battalions and Semi-Permanent Lines.* C. De F. Chandler. (44) Nov.

Mining.

Sinkings and Borings of the Kent Coal Concessions & Allied Undertakings.* (106) Vol. 41, Pt. 6.
Shaft Sinking by Electric Sinking Hoists.* (22) Oct. 6.
Liquid Air Rescue Apparatus at the Makiewka (Donetz) Rescue Station.* D. Lewitsky. (57) Oct. 6.
Giant Gold Dredges at Natoma, California.* Newton Cleaveland. (103) Oct. 7.
Recent Problems in Copper Production.* (103) Oct. 7.
Records and Costs of Core Drill Borings in 1909-10 by the Nova Scotia Dept. of Mines, with Summary of Costs for 4 Years.* (86) Oct. 11.
Electrical Equipment of the Clock Face Colliery of the Wigan Coal and Iron Company, Limited.* (57) Oct. 13.
The Ashio Copper Mine.* Thomas T. Read. (103) Oct. 14.
First Aid to Mining Machinery.* Henry M. Lane. (16) Serial beginning Oct. 14.
The Deadwood Mill at Mogollon, N. M.* John W. Kniffin. (16) Oct. 14.
The Brakpan Mine and Mill.* (16) Oct. 14.
Graphite in Province of Quebec.* (Abstract from Report, Dept. of Mines, Que.) (96) Oct. 19.
Bedlay and Bothwell Park Collieries.* (22) Oct. 20.
Mining Methods at Goldfield. Claude T. Rice. (16) Oct. 21.
Scheme for Valuing Ore in a Stope.* Lee Fraser. (16) Oct. 21.
The Cheever Mines, Port Henry, N. Y.* Guy C. Stoltz. (16) Oct. 21.
Blasting Gumbo at Toronto. (14) Oct. 21.
Concrete-Lined Coal Mine Shafts of Annabelle Mine, Annabelle, W. Va.* E. C. Auld. (13) Oct. 26.
Sizing With or Without Screens.* Carl F. Dietz and Dyke V. Keedy. (105) Nov.
The New Electric Hoists at Ray, Ariz.* (45) Nov.
Safety Through Systematic Timbering.* (In Mines.) (45) Nov.
Coal Mining in Arkansas.* (45) Nov.
Tentative Plan of Shaft Bottom.* William B. Crawford. (45) Nov.
The Cost of Mining Coal in Iowa. Edward A. Sayre. (From *Iowa State College Engineer.*) (45) Nov.
Centrifugal Mine Ventilators.* (45) Nov.
Les Mines de Fer et la Sidérurgie dans l'Amérique du Sud et Principalement au Chili.* Ch. Vattier. (32) Aug.

Miscellaneous.

Recent Advances in High Temperature Measurement. J. A. Harker. (From *Science Progress.*) (19) Nov. 4.

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Municipal.

The Engineering Aspect of Town Planning. John Bryce, M. Inst. C. E. (Paper read before the Scottish Burgh Officials.) (104) Sept. 29.
Municipal Works at Paignton. C. Owen Baines. (Paper read before the Inst. of Mun. and County Engrs.) (104) Oct. 6.
Cost Data of Experimental Water-bound Macadam and Bituminous Macadam Roads Constructed by the Illinois Highway Commission.* (86) Oct. 11.
The Paving and the Care of Streets. Edwin A. Fisher, M. Am. Soc. C. E. (13) Oct. 12.
Macadam Road Surfaces. (104) Serial beginning Oct. 13.
The Selection of Street Pavements. Geo. W. Tillson. (Paper read before the Inter. Municipal Congress, Chicago.) (86) Oct. 18.
Experimental Work in Preserving Surfaces of Old Macadam or Gravel Roads Against Effects of Automobile Travel. (86) Oct. 18.
Earth Roads, Construction and Maintenance. Robert Gibbes Thomas. (Paper read before the South Carolina Good Roads Assoc.) (96) Oct. 19.
The Good Roads of Madison County, Tennessee. Atwell Thompson. (Abstract of paper read before the International Good Roads Congress.) (96) Oct. 19.
A New Consistometer for Use in Testing Bituminous Road Materials.* W. W. Crosby. (104) Oct. 20.
Paving and Care of Streets. (14) Oct. 28.
The Pavements of the Borough of Manhattan, New York City. (14) Oct. 28.
Distributing and Mixing Machinery for Construction and Maintenance of Bituminous Pavements and Surfaces.* Arthur H. Blanchard, M. Am. Soc. C. E. (60) Nov.
Brick Road Construction about Cleveland and Buffalo.* (60) Nov.
Les Avantages du Goudronnage des Chaussées ses Effets sur la Végétation. Guglielminetti. (33) July 22.

Railroads.

The Present Position of Electric Traction on Main Lines in Europe. J. B. Sparks. (77) Sept.
Recent Electric Locomotive Practice and the High-Tension Direct-Current Railway System.* Allan Monkhouse. (77) Sept.
Some Experiments with Trucks. George G. Floyd. (61) Sept. 19.
Locomotive Exhibits at Turin.* (12) Serial beginning Sept. 29.
The Use of Electric Locomotives for Shunting Purposes. Albert H. Marshall. (Abstract of paper read before the Cleveland Inst. of Engrs.) (73) Sept. 29.
Reinforced Concrete for Railway Engineering Works.* J. D. W. Ball, Assoc. M. Inst. C. E. (12) Serial beginning Sept. 29.
Note on Steel Tires for High Speed Locomotives.* P. H. Dudley. (88) Oct.
Note on the Electrification of the old Giovi Line on the Italian State Railway.* (88) Oct.
Review of Traffic Questions in France. C. Colson. (From *Revue Politique et Parlementaire.*) (88) Oct.
Private Owner's Wagons; Specifications and Tests for Materials.* (21) Oct.
New Locomotive Sand Box.* (21) Oct.
Preservative Treatment of Hemlock and Tamarack Ties.* (87) Oct.
New Locomotive Terminal, Chicago & Alton, at Bloomington, Ill.* (87) Oct.
Methods and Cost of Building a Railroad Extension.* (86) Oct. 11.
Method of Supporting and Fastening Rails in New Northwestern Train Shed, Chicago.* (86) Oct. 11.
An External Throttle Valve for Locomotives.* (13) Oct. 12.
Construction Work on the Cleveland Short Line.* (15) Oct. 13.
Locomotive Proportions. Lawford H. Fry. (12) Oct. 13.
Tramway Track-Methods of Construction and Maintenance. J. Grierson, H. Mattinson and R. B. Holt. (Papers read before the Municipal Tramways Assoc.) (73) Oct. 13.
Hoosac Tunnel Single-Phase Locomotives.* (17) Oct. 14.
Oil and Waste Reclaiming Apparatus, Canadian Pacific Ry.* (18) Oct. 14.
Cost Data on Railway Grade Works in Mexico in 1907.* Howard Egleston, M. Am. Soc. Engr. Contr. (86) Oct. 18.
Machines for Boring and Trimming Ties and Driving Screw Spikes.* (13) Oct. 19.
The International Franco-Spanish Noguera-Pallaresa Railway. (12) Oct. 20.
The Single-Phase Tramway in the Suburbs of Parma.* (73) Oct. 20.
Locomotive with Smoke-Box Superheater for the Great Northern Railway of Ireland.* (12) Oct. 20.
Construction Work on Milwaukee Belt Section of the Milwaukee, Sparta & Northwestern.* (15) Oct. 20.
Right of Way Signs on Chicago Great Western.* (15) Oct. 20.
Revetment Work on the Missouri Pacific.* (15) Oct. 20.
Power Distributing System of the Oakland, Alameda and Berkeley Suburban Lines of the Southern Pacific Company.* (17) Serial beginning Oct. 21.
The New Rapid Transit Route Between New York and Newark.* (14) Oct. 21.
Panama Canal Electric Towing Locomotives.* (27) Oct. 21; (62) Oct. 16; (86) Oct. 18.

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Demonstration Train on the Atchison, Topeka & Santa Fé Ry.* (18) Oct. 21.
Uniform Signaling. (From paper read before the Ry. Signal Assoc.) (18) Oct. 21.
Mikado Type Locomotives for the Great Northern Ry.* (18) Oct. 21.
The American Railroad Ditcher.* (18) Oct. 21.
Stresses in Locomotive Boilers.* W. H. Burleigh. (64) Oct. 24.
Methods of Railway and Street Grade Separation in Cities. Robt. H. Whitten. (86) Oct. 25.
Two Interesting Mountain Railways, Operated by Geared Locomotives.* (13) Oct. 26.
Cable Incline Railways.* (13) Oct. 26.
Aerial Tramway and Cable Inclines for Passenger Traffic in Colorado.* (13) Oct. 26.
The "Tensio" Railway Screw-Coupling. (11) Oct. 27.
Locomotive Efficiency and Condition Reports. N. D. Ballantine. (15) Oct. 27.
A New Fourteen-Wheeled Express Locomotive.* Charles R. King. (19) Oct. 28.
The Reclamation and Lining of Roper Tunnel on the Seaboard Air Line Railway, a Description of Handling a Large Cave.* Harvey Stanley. (14) Oct. 28.
Steel Postal Construction and Specifications. (18) Oct. 28.
The Cost of Transportation on the Erie Canal and by Rail.* (From *Bulletin,* Bureau of Ry. Economics.) (18) Oct. 28.
A Steam Storage Locomotive Built by the Lima Locomotive & Machine Co.* (18) Oct. 28.
A Safety Appliance Ladder.* (For Freight Cars.) (18) Oct. 28.
The Grand Trunk Pacific Railway.* Frederick A. Talbot. (9) Nov.
Instructions for Inspecting Bridges and Culverts, Great Northern Ry.* W. B. Irwin. (86) Serial beginning Nov. 1.
A New System of Electric Industrial Railway.* (13) Nov. 2.
Colorado & Southern Extension to Cheyenne.* (15) Nov. 3.
The Peking-Kalgan Railway.* F. C. Coleman. (46) Nov. 4.
Power and Transmission Methods of the Prussian Hessian State Railways.* (17) Nov. 4.
Mikado Type Locomotives for the Missouri Pacific Ry.* (18) Nov. 4.
La Traverse en Ciment Armé Idéale. (84) Sept.
Le Tunnel sous l'Elbe, à Hambourg.* (84) Sept.
Les Voies d'Accès au Simplon.* A. Mauguin. (38) Oct.
Note sur Deux Types de Locomotives.* Séguela. (38) Oct.
Le Chemin de Fer Electrique Nord-Sud de Paris, Production et Distribution du Courant.* (33) Oct. 21.
Les Tunnels sous l'Hudson, à New York.* Alexandre Delisle. (33) Serial beginning Oct. 21.
Drei neue Pyrenäenbahnen.* A. Bencke. (102) July 15.
Die Beseitigung der Lokomotivschlacken. F. Zimmerman. (102) Serial beginning July 15.
Untersuchung und Berechnung der Blasrohre und Schornsteine von Lokomotiven. Strahl. (102) Serial beginning Oct. 1.
Widerstände von Zügen verschiedener Art. (102) Oct. 1.
Schlitten-Lokomotive für Förderungen auf Schnee-Schlittenkufen.* A. Riehl. (102) Oct. 1.
Der Blockapparat von Tyer in seiner neuesten Anordnung.* A. Tobler. (107) Oct. 14.
Die vierachsigen Gaswagen mit Presspumpeneinrichtung der badischen Staatsbahnen.* Hefft. (102) Oct. 15.
Verhalten der Angestellten bei Fahrhindernissen auf Hauptbahnen.* Simon. (102) Oct. 15.
Dampf-Staubsauger von Köster.* J. Pintsch. (102) Oct. 15.
Ueber elektrische Vollbahnbetriebe.* E. Scheichl. (53) Oct. 20.
Die elektrische Bahn Biasca-Acquarossa.* W. Kummer. (107) Serial beginning Oct. 21.

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New Subway for the City of Toronto.* (86) Oct. 11.
A German Electric-Omnibus Trolley Line.* J. B. Van Brussel. (13) Oct. 12.
Large New Carhouse at Los Angeles.* (17) Oct. 12.
Two-Car Train Operation for City and Suburban Travel. C. J. Franklin. (Abstract of paper read before the Am. Elec. Ry. Transportation and Traffic Assoc.) (17) Oct. 13.
Report of the Committee on Way Matters.* (Am. Elec. Ry. Eng. Assoc.) (17) Oct. 13.
Semi-Steel Cars for Houston, Tex.* (17) Oct. 14.
Report on Los Angeles Transit Conditions.* Bion J. Arnold. (17) Oct. 21.
Operation of Near-Side Cars in Philadelphia.* (17) Oct. 21.
Observations on Near-Side Cars in Buffalo. (17) Oct. 28.

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Hearing in Buffalo on International Traction Reorganization, an Account is Given of the Methods used by B. J. Arnold in Determining the Cost to Produce New as of April 1, 1911, the Physical Property of the International Traction Company of Buffalo. (17) Nov. 4.

Sanitation.

A Successful Voluntary Joint Municipal Enterprise. (Description of Outlet Sewer for Counties of Essex and Union in the State of New Jersey.) Alexander Potter. (98) Sept.
Prestwich Sewage Scheme.* (104) Sept. 29.
The Engineering Problems of Land Reclamation.* A. M. Shaw. (Paper read before the Louisiana Eng. Soc.) (1) Oct.
The Sanitary Problems of the Catskill Aqueduct. David S. Flynn. (2) Oct.
Frome Sewage Purification Works. F. W. Jones. (Paper read before the Assoc. of Somerset Surveyors.) (104) Oct. 6.
Notes on the Theory and Practice of Percolating Filters. J. E. Farmer. (Paper read before the Assoc. of Managers of Sewage Disposal Works.) (104) Oct. 6.
Fan System versus Direct Radiation.* Ira N. Evans. (64) Oct. 10.
Toronto Main Drainage Works.* (96) Oct. 12.
The Relative Values of Different Public-Health Procedures. H. W. Hill. (13) Oct. 12.
Capacity of Conductor Pipes.* (101) Oct. 13.
Heating and Ventilating High School Buildings.* Samuel R. Lewis. (105) Oct. 13.
A Storm-Water Sewer at La Grange.* (14) Oct. 14.
The Blissville Trunk Sewers in Long Island.* (14) Oct. 14.
Notes on Collecting the Sewage of New York City at a Central Point. (14) Oct. 21.
Methods, Diagram and Formulas for the Design of Tie Drainage Systems.* Benj. L. Parker. (86) Oct. 25.
Six Months' Financial Operating Results of the Garbage-Reduction Plant of Columbus, Ohio. (13) Oct. 26.
New Main Low-Level Sewer for the South Side of London. R. M. Gloyne. (Abstract of paper read before the Inst. of Mun. and County Engrs.) (12) Oct. 27.
Operating Results of the Sewage Clarification Works of Emschergenossenschaft.* P. E. Mebus. (Abstract from *Techniches Gemeindeblatt.*) (86) Nov. 1.
A Subway Tube as a Temporary Storm Water Sewer.* (14) Nov. 4.
Aerobic and Anaerobic Decomposition of Sewage. George W. Fuller. (14) Nov. 4.
The Disposal of the Sewage of Chicago. (14) Nov. 4.

Structural.

An Analysis of the Stresses in Guy Wires.* W. M. Wilson. (4) Oct.
Economic Construction of Storage Bins and Trestles at Cement Plants.* W. S. Marston. (4) Oct.
Manufacture and Use of Concrete Blocks.* Robert F. Havlik. (67) Oct.
Cement Stock Houses.* Josiah Gibson. (67) Oct.
Destruction of Cement Mortars and Concrete through Expansion and Contraction.* Alfred H. White. (67) Oct.
The Aligning of Shafting.* George W. Loggie. (Paper read before the National Assoc. of Cotton Manufacturers.) (20) Oct. 12.
Report of the Committee on Buildings and Structures.* (Am. Elec. Ry. Eng. Assoc.) (17) Oct. 13.
The Foundations of the Bamberger Building, Newark.* (14) Oct. 14.
The New Canadian Pacific Terminal at Victoria Harbor; The Eastern Lake Terminus of a New Grain Route Includes Harbor Work, Wharf Construction, Elevator and Warehouse Erection.* G. G. Ommanney. (14) Oct. 14.
Structural Details of the Addition to the Hotel Astor, New York.* (14) Oct. 14.
Tests of Nickel-Steel Riveted Joints. (From *Bulletin,* Univ. of Ill. Exper. Station.) (62) Oct. 23.
Why do Reinforced-Concrete Buildings Fail? Ernest McCullough, M. Am. Soc. C. E. (13) Oct. 26.
A Light Reinforced-Concrete Prison Wall at the New Jersey Reformatory, Rahway, N. J. Wm. M. Torrance, M. Am. Soc. C. E. (13) Oct. 26.
A Reinforced Concrete Candy Factory.* Arthur G. Hoadley. (14) Oct. 28.
The Foundation Girders in the United Fire Company's Building, New York.* (14) Oct. 28.
Cost of Constructing Stamp-Mills. Charles T. Hutchinson. (103) Oct. 28.
Fixed-End Columns in Practice.* C. T. Morris, M. Am. Soc. C. E. (13) Nov. 2.
Underpinning a Reinforced-Concrete Factory Building.* (14) Nov. 4.
Two High Chimneys for a Boston Sugar Refinery. (14) Nov. 4.
A Subway Delivery Entrance at the Rockefeller Estate.* (14) Nov. 4.
Appareil pour la Mesure Directe de la Charge d'un Fil Métallique Tendu.* F. Largier. (33) July 22.
L'Expansion et le Retrait du Béton lors de sa Prise.* (84) Sept.

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Vitesse Dangereuse du Choc entre Deux Barres, Remarques sur le Mémoire de M. Henry. J. Resal. (93) Oct.
Tensions dans les Metaux Déformés à Froid.* Heyn et Bauer. (93) Oct.
Eisenbetonkonstruktionen bei Biegung und bei exzentrisch wirkenden Druck- odér Zugkräften. Einheitliche Verfahren zur Bemessung derselben. Rich. Wuczkowski. (79) Vol. 15.
Unmittelbare Dimensionierung von Eisenbeton-Querschnitten für zusammengesetzte Festigkeit.* (51) Serial beginning Sup. 19.
Kurven reiner Schubbeanspruchung des geraden Balkenträgers rechteckigen Querschnittes. Josef Wagner. (53) Serial beginning Sept. 29.
Das neue Krankenhaus der Wiener Kaufmannschaft.* Ernst v. Gotthilf. (53) Sept. 29.
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PROVISION FOR UPLIFT AND ICE PRESSURE IN DESIGNING MASONRY DAMS.

By C. L. Harrison, M. Am. Soc. C. E.

To be Presented December 20th, 1911.

There has been much discussion recently by engineers and the technical press on the upward pressure of water and ice thrust in dams. The following brief statement is written to bring the subject before the Society in the hope that it will be fully discussed.

Uplift.

For convenience in discussing this subject, reference is made particularly to masonry dams on rock foundations. The principles involved will apply equally to other foundations and to dams built of other materials. The upward pressure may be due to water getting into the foundation of the dam or into the dam itself.

Foundations vary so much in character, that it is necessary to study each particular site before deciding to what extent water may get into them.

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In the *Proceedings* of this Society, the Papers and the Discussions on Papers will hereafter be printed so that each will commence on an odd-numbered page. This is done by special request, in order to enable members who wish to do so to separate the Papers and Discussions for filing under various engineering subjects.

(1) In the case of a foundation of hard, sound rock, without either horizontal or vertical seams, there is no reason to expect that water will get into it and produce an upward pressure, and, in the design, no allowance should be made for it. In such cases the junction between the masonry and the foundation can easily be made water-tight.

(2) In the case where the foundation is stratified with well-defined horizontal seams, and the dam is located near a fall or rapids in the stream, so that the water may flow from the seams at the toe of the dam as freely as it enters them from the reservoir, the upward pressure will be approximately equal to the static head at the heel and gradually decrease to zero at the toe of the dam.

(3) Take a foundation similar to the foregoing in every respect except that the water in the seams of the rock cannot escape freely near the toe of the dam, but must flow some distance down stream through rock or other materials before it reaches the surface of the ground, or must rise vertically to the surface: Then the upward pressure at the heel will be equal to the static head, and that at the toe will be equal to the head required to overcome the resistance to the water escaping at that point.

While these three cases present well-defined conditions, it is probable that at most sites the conditions will lie between those presented in Case 1 and in Cases 2 and 3, that is, the water will not be in the foundation throughout its entire area, but will cover only a part of this area. This makes it necessary to study the foundation carefully at each site in order to determine to what extent water may get into it. When this upward pressure exists, weight must be added to the dam by additional masonry to counterbalance it. Generally, it will be found cheaper to make large expenditures to provide a cut-off in the foundation, which will not only reduce the uplift, but will also save the water. Such a cut-off should be located at the heel of the dam. If it is located under the middle of the dam, there would be an upward pressure under the up-stream half of the dam, due to the full head of the water in the reservoir.

A thorough investigation, by borings and otherwise, should be made of the foundation at each site before the dam is designed, and a liberal margin should be allowed over what the engineer (basing his figures on his experience and best judgment) believes to be safe.

In order to determine what allowance to make for pressures due to water which gets into the dam itself, one must first decide on the character of the construction. With suitable stone, sand, and cement, it is possible to build a masonry dam which will have no horizontal cracks or seams, and it is also possible to provide against vertical cracks, to a large extent, by expansion joints. Water in vertical cracks, however, does not produce an upward pressure. In such structures very little, if any, allowance should be made for the upward pressure due to water getting into the masonry.

If the materials for building water-tight masonry are not to be had at the site of the dam, and it is very expensive to import them, it is generally advisable to adopt a different class of masonry, which will probably be more pervious and also more difficult to construct without horizontal cracks or seams, thus allowing the water to enter the dam, and resulting in upward pressures. The extent of such pressures will depend on the character of the masonry and the care with which it is built, all of which must be known before an estimate can be made of the extent to which the water will get into the dam. The effect of this upward pressure, however, must be counteracted, either by increasing the section of the dam or by increasing its height above the water level in the reservoir, or by both. In many cases it may be advisable to provide drainage wells near the up-stream face to intercept the water and carry it off through pipes at the toe of the dam, thus reducing or eliminating its effect in the main body of the dam. After determining the type of masonry to be constructed, it is still a question of judgment, based on observation, tests, and experience, as to what the upward pressure in the dam will be.

The upward pressures in the foundation, and in the dam itself, should be considered separately before a decision is reached.

Ice Pressure.

After ice has formed on a reservoir, it contracts under a lower temperature and expands under a higher temperature. The contraction due to the cold weather of winter results in cracks which fill with water that freezes and produces a continuous sheet of ice over the surface of the water. Under the higher temperatures of the late winter and early spring, the ice is warmed up and expands. On reservoirs this results in the ice being forced up the banks, unless the inflow of water should raise the level sufficiently to provide the increased area.

In case the banks are vertical or nearly so, the expansion produces a pressure on the sides of the reservoir and results in the ice being compressed to some extent and buckling up out in the reservoir. In some cases the ice may be crushed.

In designing dams, the ice pressure should be considered, but it is of less importance than the upward pressure of water in the dam and its foundations. The ice is in sight and can be cut along the face of the dam, and thus relieve the pressure. Generally, in storage reservoirs, the period of heavy ice pressures is also that of low water, and the pressure would come against the dam at a point considerably below the high-water level, where the dam is strong enough to resist it. In many cases, the dam is located in a narrow gorge where the full effect of the ice field cannot reach it. The dam should be strong enough to resist the water pressure and the additional pressure caused by the ice, but what this will be depends on the thickness of the ice and other local conditions at each site, and no general rule can be made to cover all cases.

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HOW TO BUILD A STONE JETTY ON A SAND BOTTOM IN THE OPEN SEA.

By Henry C. Ripley, M. Am. Soc. C. E.

To be Presented January 3d, 1912.

Introduction.

Within the last 25 years a method of jetty construction has been developed in the United States, which, for stability and economy, has never before been approached, as far as the writer is aware. As no complete description of this method has ever been published, it is the writer's purpose to discuss it in detail, in accordance with its most recent development, and give the reason for each detail, so that those who are unfamiliar with work of this class may appreciate its utility. The order of construction by which bar advance may be minimized, if not wholly prevented, will also be described.

Explanation and Definitions.

A jetty consists of the four distinct elements: the foundation, the core, the side-blocks, and the crest or cap-blocks. That portion above

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the foundation, taken together, is the superstructure. The foundation is a thin layer of stone—usually about 3 ft. thick—of the full width of the jetty; that part projecting beyond the superstructure is called the apron. The core is the interior portion of the superstructure, and the crest-blocks and side-blocks are the large blocks of stone covering the crest and sides of the core. A section of the superstructure will have the form of a trapezoid. The slopes of the sides will be such as the stone assumes in placing, and will vary according to the degree of exposure to wave action and the size of stone used. Generally, however, they may be kept within the limits of one horizontal to one vertical (1:1) and two horizontal to one vertical (2:1). The slopes will generally be unequal, because one side will usually have greater exposure to the waves than the other. The top width will vary with the degree of exposure to wave action, but it should not be less than 10, nor more than 20, ft. If the latter figure is exceeded, it will indicate either improper construction or unusual exposure to wave action. Naturally, the width at the bottom will depend on that at the top, the side slopes, and the height of the work. The volume of material, and hence the cost of the completed work, will vary with the top width, the side slopes, and the height; therefore it is important to prevent these dimensions from assuming unnecessary proportions. To be sure, the height of the jetty will depend on the depth of the water where it is located, and this cannot be controlled. However, by preventing scour in advance of the work, under-scour by cross-currents through or under it, and the undermining of the sides by wave action or longitudinal scour by current action, much may be done to curtail the height which might be necessary were these details neglected.

Before proceeding further it will be useful, and necessary to a clear understanding, to define the different classes of stone entering into the construction. These are as follows:

Small Rip-Rap.—This consists of small irregular pieces of stone, each weighing from 10 to 100 lb., which may be handled by one man; it is sometimes called "one-man stone."

Spalls or Chips.—These are pieces of stone smaller than the small rip-rap, and are usually handled with a shovel.

Large Rip-Rap.—This consists of irregular pieces weighing from 100 to 1 500 lb., or even more, of almost any shape which the quarry will produce, although very thin and flat pieces are objectionable because they tend to break into pieces in placing and it is impossible to make a good bond with them.

Large Blocks.—These consist of more or less regular pieces of stone, weighing from 1 to 10 tons, or more.

METHOD OF CONSTRUCTION.

The foundation must be constructed first. It is made of small rip-rap, large rip-rap, and spalls. There must be enough large rip-rap to hold the small rip-rap in place against wave action, and enough spalls to fill the voids in the rip-rap and prevent the undermining effects of cross-currents by working through and under the mass. It must also be of sufficient thickness to prevent the breaking waves from jetting through the mass, and washing out the sand from under it. A liberal allowance of spalls will always assure a secure foundation against current and wave action through the mass. Where wave action is very great, it is necessary to place the small rip-rap first and cover it with the large rip-rap, in order to hold it in place, the voids in the latter being filled with small rip-rap. Where wave action is not great, the large rip-rap may be dispensed with and the thickness reduced.

In fixing the width of the foundation, two things must be considered, namely, the width of the base of the superstructure and the width of the apron. The first will depend on the height and on other conditions which will be discussed later. The width of the apron must be such as to provide for any undermining and settlement due to overfall during or after the completion of the whole work, and for that due to scour, principally along the channel face. The probable depth of scour can generally be predicted with a considerable degree of certainty, and, by watching the results as the work progresses, the amount of deepening caused by overfall may be closely approximated for ordinary conditions. For those extraordinary conditions which are due to great and unusual storms, the results are more problematical. However, the direction from which great storms come is generally known, and, therefore, the side of the jetty on which the overfall effect will occur. When this happens to be on the channel side, the provision for channel scour will have provided sufficiently for any action due to overfall which is likely to occur. Where there are two jetties, the one suffering from overfall on the outside will be in the lee of the other jetty, and the effect will be thereby diminished. It will generally be found, therefore, that the maximum overfall effect will be developed during construction, and if this be ascertained and fully provided for, no great fears need be entertained for the stability of the work after it shall have been completed.

In determining the necessary width of the apron, in addition to the provisions for overfall and current scour, a width of from 4 to 6 ft. should be provided for a berm at the base of the superstructure. This berm will furnish a secure footing for the large blocks covering the sides of the superstructure, and will prevent them, when rolling down, from continuing on down the slope of the apron. It will also serve as additional security against undermining the superstructure in case of excessive scour from any cause. The slope assumed by the apron will depend on the degree of exposure to wave action; hence, the deeper the water in which it is placed the steeper will be the slope up to the angle of repose, which may be taken at 45 degrees. Generally, this slope may be taken at from 1 : 1 to 1 : 1½. It will always be steeper than the adjacent side slope of the superstructure, unless the construction be made in absolutely quiet water.

In designing the foundation for a jetty, it will be necessary to determine its width at every point, as this will vary in accordance with the conditions mentioned. As an example, let it be required to determine the width of the foundation at a point where the water is 12 ft. deep, and let it be assumed that the top of the jetty is to be 3 ft. above the water surface, that the top width is to be 15 ft., that the side slope on the channel side will be 1 : 1¼, and on the sea side 1 : 1½. Let the foundation be 3 ft. thick; suppose the scour on the channel side to be down to 25 ft. and on the sea side to 16 ft., and assume a slope of 1 : 1 for the apron on the channel side and of 1 : 1¼ on the sea side, with a berm of 5 ft. on each side. The height of the superstructure will then be 12 ft., and its bottom width will be $15 + 15 + 18 = 48$ ft. The width of the apron on the channel side will be $5 + 13 = 18$ ft., and, on the sea side, it will be $5 + 5 = 10$ ft. The total width of the foundation at this point will then be $48 + 18 + 10 = 76$ ft.

When properly constructed, the foundation serves two important purposes: It secures the superstructure against settlement from undermining, and it protects the bottom, on which the jetty is to rest, from scour in advance and during the building of the superstructure. When once commenced, the construction of the foundation should be pushed as rapidly as practicable, for any delay will permit scour at the unfinished end, which must afterward be filled in with stone, and any deficiency in the full width may permit the edges to drop down, and additional stone will be needed to restore the loss in height. Any temporary deficiency in width which may be necessary in the course of construction, therefore, should be confined to the apron, where a moderate settlement will entail no loss, that is, beyond the base of the superstructure and berm.

Superstructure.

On the completion of the foundation, the superstructure may be commenced, or, in some cases, it may be commenced before the entire completion of the foundation. This will be when its building-up will not cause an increase in the cross-currents in advance of the foundation, and where the concentration of the outward flow is not likely to cause advance scour.

The first portion to be constructed is the core, which is composed of large and small rip-rap and spalls. The small rip-rap and spalls secure tightness, and the large rip-rap prevents the small rip-rap from spreading out and flattening the slope on account of wave action. The flattening of the slope means greater volume, and, therefore, increases the cost of the work.

Where the water is deep, or where there is little wave action, the core may be commenced by depositing the stone along the axis of the superstructure, using large and small rip-rap and spalls in such proportions that the small rip-rap will fill the voids in the large rip-rap, and the spalls will fill those in the small rip-rap. As the core of the wall approaches the elevation of low tide, or, say, within about 3 ft. of that plane, this form of construction will not suffice to prevent the stone from spreading out and flattening the side slope. When this stage is reached, the sides of the work must be covered with large rip-rap which must be brought up to a height above the general level of the work in two ridges parallel with the axis of the superstructure. The space between these two ridges will then be filled with small rip-rap and spalls, and, in some cases, it may be necessary to use also some large rip-rap, in order to prevent the smaller stones from being washed out by the waves. Then the ridges must be raised again, and the space between them filled as before. This process must be continued until the proper height of the core is reached, the top having been completely covered with large rip-rap. This height should be such that, with the addition of the crest-blocks, the work will be brought to the full height required for the superstructure after consolidation has taken place.

The allowance for consolidation is largely a matter of judgment. It will depend on the height of the wall, the character of the stone used, the intensity of wave action during construction, the number of unfilled voids in the mass, and the pounding it is likely to receive from storm waves subsequent to completion. The pounding of waves on a mass of stone sets up a vibration which causes the points of contact of the different pieces to rub on each other, and this, by wearing away the stone, permits the mass to consolidate. When this process has been continued for a certain length of time, however, this vibration becomes ineffectual in reducing the bulk, the structure practically ceases to shrink, and the mass becomes stable. Moderate wave action on the work during construction is not an unmixed evil, as it helps the stones to pack together and consolidate, and thus the subsequent shrinkage is reduced. The more nearly water-tight the jetty is made, the more efficient it will be, because there will be less leakage and waste of the water which its purpose is to constrain, and because of the smaller quantity of sand which can pass through it to the injury of the channel.

Having regard for these considerations, the allowance for consolidation will vary from 6 in. to 2 ft.; but, where the work is subjected to the usual wave action during construction, the shrinkage will rarely exceed 1 ft.

As soon and as fast as the core is finished, the side- and crest-blocks should be placed, for otherwise a severe storm would damage the uncompleted work. The side-blocks should be placed one at a time, and allowed to roll down until the sides are completely covered from the bottom up to about the elevation of low tide. Above this elevation each block must be carefully placed so as to fit as closely together as practicable. As soon as the top is reached, the surface of the core must be leveled up with small rip-rap, and, if there has been any loss in height by the washing down of the crown, the proper elevation must be restored before capping. The cap-blocks will then be selected, using only those pieces which will give the proper height to the crown, and these should be placed so as to leave as little of the sides as practicable exposed to the waves. The side-blocks should be disposed in relation to the cap-blocks so that the waves will glide over the latter rather than strike with full force against their sides. When these blocks are properly placed, the surface of the core is completely covered, and when the inevitable shrinkage due to consolidation takes place, these blocks wedge themselves together in such a way that the heaviest storm waves cannot dislodge them.

Where one side of the structure has greater exposure to wave action than the other, the larger blocks will be placed on that side, and, as the greatest force of the waves is exerted on that portion of the work above the plane of low tide, much care must be taken in building this portion. This is greatly facilitated, however, by the fact that it is always exposed to view at low water, and there can be no uncertainty as to the position of each and every block.

STONE.

The character of the stone to be used in a work of this nature is of considerable importance. Hardness and weight are prime requisites, especially for the side- and crest-blocks, and, for these, granite, gneiss, limestone, sandstone, or other stone of considerable specific gravity, should be used. The value of a stone to resist wave action varies directly with its weight under water and inversely with its surface exposure. Its value depends on its specific gravity, and to an extent which is not always fully realized. Suppose two stones, *A* and *B*, each having the same weight (say, 1 metric ton or 1 000 kg. in air), *A* having a specific gravity of 2.1, and *B* a specific gravity of 2.7. Then *A* will have a weight, under salt water, of 496 kg., and will displace 504 kg. of water, while *B* will have a weight of 608 kg., under the same conditions, and will displace 392 kg. of water. Then *B* will have a weight under water 22½% greater than *A*, a volume 22% less, and a surface exposure to wave action 15½% less than *A*. Therefore, it will have 38% more stability or power to resist wave action than *A*, while its weight in air is exactly the same.

For the foundation and core there is not the same economy in the use of heavy stone, but the large rip-rap (the main purpose of which is to resist wave action), if of high specific gravity, will enable the core to be built with a steeper side slope, and, therefore, will conduce to economy in the quantity of stone required for a given work. For this reason a limestone is generally preferred to a sandstone of the same grade as to hardness, because of its greater specific gravity. For a foundation in deep water and for the interior of a core, a stone of less hardness is not altogether objectionable, because the chips which result from handling help to reduce voids and consolidate the work sooner. In some cases, the use of a stone of small specific gravity for the foundation will give satisfactory results, with some economy in tonnage.

Order of Construction.

When jetties are designed to control the flow of water across a sand-bar, the order of construction is of vital importance. The order in which the material should be put into the work has already been given under "Method of Construction." It is here proposed to consider whether the work should be built from the shore outward or from the outer end shoreward.

Suppose that two parallel jetties are to be constructed at the mouth of a river, or at the entrance of a tidal harbor, to extend from the shore out across the bar; and suppose that the foundation of each has already been constructed. The position of the bar is determined by the equilibrium of the forces, one set of which tends to push it seaward, while another tends to push it back toward the gorge. When these forces are equal, the distance of the bar from the gorge is constant.

If the superstructure is commenced at the shore ends and extended toward the outer ends, it will have the effect of advancing the gorge toward the bar, with the resulting advance of the latter. If the work progresses rapidly, the jetties may overtake the bar advance and get across it, but such a result will always be at the cost of a considerable extension of the jetties beyond that originally required. If the work of construction progresses slowly, the jetties may never reach and cross the bar, and the expenditure may become so great that the project may be abandoned without accomplishing the purpose for which it was designed.

If, however, the construction of the superstructure be commenced at the outer end of the jetties and continued shoreward, there can be no gradual advance of the gorge toward the bar with the consequent bar advance. On the contrary, as the completed work is extended, the waterway will suffer a contraction, the old gorge will disappear, and a new one will be established at the outer end of the jetties at a point beyond the crest of the bar. With the increasing contraction of the waterway, there will be an increased current, both between the jetties and laterally through the gaps between the completed work and the shore on either side of the channel; but, as the foundation work of the jetties will prevent enlargement laterally, deepening of the channelway between the jetties will be inaugurated, and, as the greatest tendency to scour will be at the outer end of the jetties, deepening will commence at this point and extend backward with the advance of the completed work shoreward. The material thus eroded from the channelway will be carried beyond the outer ends of the jetties, where it will be either swept to one side by the littoral current or deposited in the deep water farther out.

Another advantage in working from the outer end toward shore is the facility afforded in construction. The work will thus be carried on in the lee of the finished structure, and in this way the number of possible working days is considerably increased. Where the work is being done with a floating plant, this increase in available working days may amount to from 50 to 100%, with a corresponding saving in operation expense. Even where the work is being done by using a trestle, the construction is greatly facilitated by being in the lee of the finished work, and much time may be utilized which otherwise would be lost.

For a single curved jetty, a detached breakwater, or a training wall, where waves and current are encountered, the same general method and order of construction should be followed.

Where the conditions are favorable for the construction of a trestle along the site of the work and the cars of stone are run directly on it, a most convenient method of construction is furnished. It enables the work to be carried on during weather which might be so rough that it would prevent the use of a floating equipment. It also enhances to a considerable extent the rate of progress. The floating equipment, however, is very convenient for placing the foundation, and, on a large work, a combination of the two systems may prove advantageous. It is beyond the province of this paper, however, to enter into the subject of the method of handling the stone. Either method will give entirely satisfactory results.

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PAPERS AND DISCUSSIONS

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THE DETROIT RIVER TUNNEL.

Discussion.*

By Messrs. William J. Wilgus and E. M. Walker.

Mr. Wilgus.

William J. Wilgus, M. Am. Soc. C. E. (by letter).—The remarks of Mr. Gundersen on the author's treatment of the evolution of the subaqueous tunnel design at Detroit are so far from being in accord with the facts that, in the interest of historical accuracy, the following excerpts are given from the records.

The idea of constructing the tunnel without the use of air shields, by sinking tubes into a prepared trench, surrounding them with tremie-placed concrete, unwatering, and lining them, first occurred to the writer in the latter part of July, 1905, and was communicated to his colleagues on the Advisory Board by letter dated August 7th, 1905.

The members of the Board considered the idea practicable, and discussion during the ensuing two months resulted in the conclusion that permanent steel tubes would be preferable to temporary wooden ones; that water-tight joints with gaskets were feasible, as they had been used by Mr. Carson, at Deer Island, near Boston; that the tubes in pairs 100 ft. or more in length could be built on land, launched, floated to position, and sunk on saddles; and that several methods were feasible for depositing the exterior concrete so as to envelop the tubes completely.

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* Continued from October, 1911, *Proceedings*.

In the *Proceedings* of this Society, the Papers and the Discussions on Papers will hereafter be printed so that each will commence on an odd-numbered page. This is done by special request, in order to enable members who wish to do so to separate the Papers and Discussions for filing under various engineering subjects.

Mr. Wilgus.

In the fall the writer took into his confidence several engineers, among them Olaf Hoff, M. Am. Soc. C. E., to whom he sent the following letter on September 30th, 1905:

"I have the pleasure of sending to you herewith * * * blue prints of the two sheets of suggestion 1-A which embody the method of construction that I have personally explained to you. I think that these sheets are self-explanatory, but the following brief description may also be of service to you in looking over the ground.

"(1) Excavate a trench across the river of the approximate cross-section shown on the blue print. From my experience in the silt and clay in New York Harbor and from the construction of the West Shore ore dock in Buffalo, and also from a perusal of the article on the Buffalo Breakwater, Volume 52, June, 1904, of the *Transactions* of the American Society of Civil Engineers, I am confident that the material at Detroit will stand on slopes approximating $\frac{1}{2}$:1 for a sufficient length of time to permit the later depositing of concrete. As you will note in the description of the Buffalo Breakwater, the contractors had no trouble in handling as high as 3,565 cubic yards per day of twelve hours, at depths of 63 feet, with a clamshell dredge of special design and at an actual cost of under 14 cents, the contract price having been 18 cents per cubic yard.

"(2) At a convenient distance in the rear of the dredge deposit Class B concrete for the depth of the first course of approximately three feet, by one of the three well-known methods, viz., tremie, bucket, or bag process, preferably the tremie.

"(3) On top of the first course of concrete place the forms or cores, which may either be of wood, to be later removed, or of steel to remain permanently in place. I am inclined to the use of steel shells fastened together in pairs and sunk so as to rest upon saddles and wedges that will regulate the proper locating of the forms or cores. It has been suggested that very little stiffening will be required for these shells by using a small pipe projecting, say 20 or 30 feet above the surface of the river to provide sufficient hydrostatic pressure to prevent the forms from distorting or collapsing. This of course is a detail that can be solved in a number of ways. It has also occurred to me that the waterproofing can be placed on these forms before they are floated and sunk and thus obviate the troublesome placing of waterproofing after the water is pumped out of the tunnel. These forms or cores may be in convenient lengths, say 100 feet, and wherever bulkheads are desired for separating the tunnel into cells or sections, the forms may be separated, say three feet, so that the exterior concrete hereafter described may flow between the forms and thus constitute bulkheads that can be later removed. As will be noted from the description that follows, absolute precision is not needed in the placing of the forms, as a variation of one or two inches will not cause any trouble in the placing of the interior ring.

"(4) Deposit Class B concrete by one of the three processes above mentioned so as to completely fill the trench around the forms in the manner shown on the drawing. The concrete thus placed does not form the tunnel proper but is merely an impermeable class of material replacing the water-bearing soil through which to cheaply and conveniently construct the interior ring of the tunnel proper, as described in the next paragraph. Mr. Wilgus.

"(5) As a convenient length of the exterior concrete work is completed, the water may be exhausted from the completed cells and a sufficient pressure of air used to prevent any abnormal leakage of the concrete; probably eight to ten pounds will be sufficient. The intervening bulkhead walls may then be removed and the waterproofing placed on the inside of the exterior concrete, unless the method described has been used for the retention of the steel forms with waterproofing in connection therewith.

"(6) The interior ring of concrete (Class A) may now be placed as shown on the drawing, with metal reinforcing, so as to secure a watertight structure of a continuous character from end to end. This latter feature is extremely desirable as the tunnel is tied together and acts as a continuous girder, and thus obviates any danger of distortion or local displacements from moving loads.

"(7) For the purpose of connecting the subaqueous tunnel above described through the water-bearing material adjacent to the shore, it is possible to use the first cells of the subaqueous tunnel as air chambers in connection with shafts, as shown on the drawing, and from these cells drive shields a sufficient distance to pass through the water-bearing material into the clay through which the remainder of the tunnel may be built by ordinary methods.

"The claims for the above method of construction are—

"Large saving in first cost because of the cheap method of construction combined with a method that permits the raising of the structure under the river, and hence the shortening in length of tunnel.

"Decrease in time of construction.

"Removal of risks of accident always possible with the use of shields working close to the river bed.

"Saving in lift of at least 15 feet for a traffic of from 9,000,000 to 12,000,000 tons per annum. * * *"

Mr. Hoff's reply, under date of October 6th, 1905, was:

" * * * I beg to acknowledge receipt of * * * your very interesting letter of September 30th. * * * I was much interested in your description, and as I have done considerable thinking about this matter since you first mentioned your mode of construction to me, I feel fully satisfied that the proper way is to use steel shells as suggested in your paragraph No. 3. I have done some little figuring in regard to the cost and think that they will be fully as cheap as the wooden forms, and the steel shell will itself form the best kind of waterproofing. * * * "

The preliminary specifications on which bids were requested read as follows:

" * * * For the purpose of reducing hazard, cost, time of construction, length of tunnel and lift of traffic tonnage, and also to widen the field of bidders, the Tunnel Company offers Designs *'A'*, *'B'* and *'C'*, which dispense with the necessity for the use of shields for the

Mr. Wilgus. subaqueous portion of the tunnel. A general description of these types of construction is given in the following paragraphs.

"Design *'A'* may be briefly described as a method by which the pervious material underlying the river is replaced by an imperfectly watertight material of concrete placed under water, through which, without the use of shields, the inner tubes or tunnel proper may be constructed so as to secure watertightness, continuity of strength, and good workmanship, with an absence of high air pressures. It will also be noted that this method dispenses with the use of cofferdams. The progressive stages for this design are—

"(*a*) Dredging of a Trench of the Approximate Dimensions shown on the Plan:

"While certain slopes are assumed as proper for the purpose, the Contractor is expected to inform himself on this point and make proper allowance in his bid for contingencies that may require flatter slopes and therefore more excavation than is indicated upon the plan. The Contractor will be given latitude as to the method he prefers to adopt in the use of flatter slopes than shown on the plan or of temporary sheet-piling for the retention of slopes within the approximate cross-section shown on the plan.

"(*b*) Depositing of 'two-men' stone for a depth of eighteen (18) inches on the bottom of the trench so as to form a blanket or barrier between the underlying clay and sand and the superimposed concrete.

"(*c*) The construction of temporary platforms in accordance with the permits of the United States and Canadian Governments, upon which the Contractor's machinery, including mixers, etc., may be placed for the operations herein described; said platforms to move progressively across the river as the dredging and other work permit.

"(*d*) Depositing of concrete by the tremie, bucket or other process approved by the Engineer, for a depth of approximately two (2) feet.

"(*e*) The placing of saddles with the aid of blocking and wedges upon said bed of concrete, upon which the forms are to be placed as herein described. As an alternative method, piling may be driven after the trench is excavated, and cut off at a proper height to receive the saddles so as to dispense with the use of blocking and wedges.

"(*f*) The construction on shore and floating into position of forms coupled together in pairs or otherwise, consisting of timbers or steel, as preferred by the Contractor, in convenient lengths of from fifty (50) to five hundred (500) feet, and gradually sunk into correct position on the saddles above described.

"(*g*) Placing under, around, between and on top of the forms, concrete by the bag, tremie or bucket process, as may be determined by the Engineer during the progress of the work as best qualified to insure good workmanship, so as to entirely encase the forms with concrete in the manner shown on the plans. The option is left to the Contractor of either joining adjacent forms under water in such a manner as to secure watertight connections or leave an open space between them to be filled with concrete as above described, so as to act as a bulkhead separating the adjacent forms, to be cut out after the water has been expelled as hereinafter described.

"(*h*) After the concrete placed under water has had an opportunity to thoroughly set, the water may be pumped out of the first section, and if the leakage is found to be excessive air may be used of a sufficient pressure to enable the waterproofing to be perfected and the inner tube or tunnel to be properly constructed. Mr. Wilgus.

"(*i*) Should the Contractor elect to adopt rolled steel for the forms, they shall be constructed with watertight joints in such a manner that, left in the work, they will act as waterproofing to prevent the percolation of water against the exterior of the inner tubes of the tunnel proper.

"Should the Contractor elect to use wooden forms, waterproofing may be placed on the exterior of the forms before they are sunk into position, so that when the forms are removed the waterproofing will remain in place. This method will require the use of air pressure to prevent hydrostatic pressure from distorting the waterproofing.

"(*j*) After proper measures have been taken to make each section thoroughly watertight, the inner tubes of the tunnel proper shall be constructed with metal reinforcing in the manner and of the classification of concrete shown on the plans. * * * "

This description clearly defined Design *A*, which was selected by Mr. Hoff's company as the one on which it preferred to bid, and in connection with which his company suggested certain minor modifications that did not in any way change the method, but explained the way in which the contractor intended to carry on his operations. They included such features as the substitution of sand for a rip-rap blanket, the detailed method of constructing the tubes, the use of wooden forms attached to the tubes to restrain the outward flow of concrete in lieu of sheet-piling, and certain other features, all bearing on the contractor's proposed method of accomplishing the desired result as specified by the Board.

It will be noted that Mr. Gundersen is incorrect in his references to the compulsory use of compressed air. He is also incorrect in his description of the comparative design of *A* and *C*. The latter merely differed from the former in having circumferential I-beams added to the interior of the steel tubes common to both designs.

Before the contract was closed, the contractors requested protection against any claims that might arise by reason of their use of Design *A*, and the patent indemnity clause was modified as appears in the second paragraph of the following extract from the contract.

"9. The Contractor hereby covenants and agrees to indemnify and save harmless the company for, and from, all loss, damage, claims, suits, recoveries, or judgments, which may arise, or may be made, had, brought or recovered by reason of, or on account of, any of the materials, tools, implements, machinery, fixtures, or anything used in or about the work to be performed under the contract, being infringements of, or being claimed to be infringements of, Letters Patent issued by the United States or any foreign country.

Mr. Wilgus. "But this shall not be construed to make the Contractor liable for any claims, suits, recoveries or judgments which may arise or may be made, had, brought or recovered by reason of the employment or use of any of the plans and methods specified in Design *A*, and the company agrees to protect the Contractor from any such claims."

From this it will be seen that Mr. Hoff's company asked and received protection in the use of the Tunnel Company's Design *A*, which is hardly consistent with the statements made by Mr. Gundersen.

A year later Mr. Hoff was given access to the writer's patent files, as shown by the following letter:

"DETROIT RIVER TUNNEL COMPANY,
"DETROIT, Mich., February 1, 1907.

"MR. H. H. WALDRON,
"Secy. to Chairman, Advisory Board of Engineers,
"New York, N. Y.

"DEAR SIR: I have your favor of the 29th ulto., and acknowledge receipt of Mr. Wilgus' portfolio containing full reports on tunnel patents, etc.

As mentioned at the last meeting of the Advisory Board, I gave Mr. Hoff access to my patent file, which he is now studying. There are several documents in Mr. Wilgus' portfolio of which I do not have copies and I will give Mr. Hoff an opportunity of studying them. We will take good care of the portfolio and return it in a short time.

"Yours truly,
"W. S. KINNEAR."

Afterward Mr. Hoff took out the patents referred to by Mr. Gundersen, but these were not brought to the notice of the writer until about the time of their issuance in December, 1908. These patents, in addition to embracing some of the features of Design *A*, cover many of the very ingenious steps devised by members of the contractor's staff in the performance of the contract, several of which have long been known to the art.

It should be added that in the recent discussion of the writer's paper before the Institution of Civil Engineers, at London, the fact, until then unknown to the writer, was brought out that J. C. Meem, M. Am. Soc. C. E., in October, 1897, suggested tunnel construction on lines quite similar to those used at Detroit.

The value to the Profession of this recital of the evolution of the design first used at Detroit, apart from the wish to have the Society records accord with the facts, is the knowledge that the use of the method is open to all, and in a variety of ways that may appeal to the engineer or contractor as best suited to local conditions.

Mr. Walker. E. M. WALKER, ASSOC. M. AM. SOC. C. E. (by letter).—The writer, having been in charge of the survey and alignment work on the Detroit River Tunnel, is especially interested in Mr. H. F. Dunham's

Mr. Walker.

statement that water gauges might have been used for transferring levels across the river, instead of instrumental work. In fact, such an idea had occurred to him, but he did not believe that float guages of sufficient and equal sensitiveness for the purpose could be devised without considerably greater expense than the 50 cents estimated by Mr. Dunham, and also in view of the constant disturbance of the surface by the large volume of vessel traffic, and the further possibility of error due to the much greater current velocity on the Canadian side of the river, and the idea was abandoned. The instrument work was not as expensive as the description indicates, for, according to the writer's recollection, the actual time chargeable to this work was not much more than about a day for four men, which, at the salaries paid, would make the cost ten or twelve dollars. Confidence in the accuracy of the result was, in the writer's judgment, well worth this expense. Fixed gauges, graduated to tenths, were used to control the dredging, and these gave an approximate check, but these readings, although rough, seemed to have enough variation to justify the instrumental method.

In reference to the measurement of the base lines for the final triangulation, part of the measurement of the Detroit base line was done with the tape supported only at the ends under a tension of 24 lb. The 100-ft. points were indicated by plumb lines of No. 30 hard brass wire. This method was used over ground where it was impracticable to maintain a line of supports, and was adopted as most expedient. To the surprise of the engineers, the measurements checked more closely than when the tape was supported, due apparently to eliminating the friction on the supports. This accounts for the lower variation in the measurements of the Detroit base line, as noted in the paper. Since making these measurements the writer has been pleased to note several instances where accurate measurement has been done successfully in this manner, so that the method now appears less radical than it seemed at that time.

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REINFORCED CONCRETE BRIDGE ACROSS THE ALMENDARES RIVER, HAVANA, CUBA.

Discussion.*

By Messrs. L. J. Mensch and G. B. Strickler.

Mr. Mensch.

L. J. Mensch, M. Am. Soc. C. E. (by letter).—The authors of this excellent paper lay stress on the fact that the bridge was built with a large unbalanced thrust on compressible ground, and that it was of vital importance to design the bridge as light as possible. In the face of the fact that great progress has been made in the application of concrete and reinforced concrete to arch bridges during the last twenty-five years, it is rather surprising that an unusually massive design was used.

It is a fact that properly designed ribbed-arch bridges are in many cases lighter than solid-arch bridges. In the 190-ft. arch, however, the thickness of all ribs and connecting slabs would make a solid arch having an average thickness of more than 3 ft. 6 in. at the crown, and of 5 ft. 3 in. at the abutments.

The adoption of reinforced concrete might have allowed a great lightening of the bridge and of the piers, and also of the unbalanced thrust.

In an arch bridge of 200 ft. span and 35 ft. rise, described by the writer,† the ribs are 8 ft. 10¾ in. from center to center, and the thrust is about 625 000 lb., which is one-half of the thrust shown in Fig. 1.

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*This discussion (of the paper by Eugene Klapp and W. J. Douglas, Members, Am. Soc. C. E., published in *Proceedings* for September, 1911, and presented at the meeting of November 1st, 1911), is printed in *Proceedings* in order that the views expressed may be brought before all members for further discussion.

† "Reinforced Concrete Pocketbook," p. 177.

In the *Proceedings* of this Society, the Papers and the Discussions on Papers will hereafter be printed so that each will commence on an odd-numbered page. This is done by special request, in order to enable members who wish to do so to separate the Papers and Discussions for filing under various engineering subjects.

Mr. Mensch.

The adoption of struts was a good expedient, which, like that of ties, is only too rarely used. There must have been very weighty reasons for the omission of sheet-piling around the piers, and, as it was omitted, the writer thinks the ground must have been very much better than would appear from the description in the paper.

The authors' remarks in regard to the design of the arches by the common or static theory and by the elastic theory are likely to disappoint those who wish to be instructed by such a paper on a subject about which so much mystery and confusion seem to exist. While it takes some time and effort to master the elastic theory, probably too much for the busy engineer to acquire if he did not learn it at school, its results for the design of arches are so simple that their application is within the reach of every engineer.

The writer will endeavor to give these results in as simple a way as possible, and hopes that it will help to clear a subject which is generally so little understood.

(1) The elastic theory teaches that the most favorable line of pressure is obtained when the dead load and one-half of the live load, uniformly distributed over the entire arch, is used in finding the funicular polygon. While the line of pressure, in a bridge with open spandrel construction, like the one in question, is very closely a parabola, it deviates considerably in the case of earth-filled arches. The writer has succeeded in evolving a very simple method of finding the line of pressure for earth-filled arches, and the ordinates of the pressure lines can be taken from Table 4, in which *a* denotes the weight of the bridge per square foot at the crown plus one-half of the live load, which is usually taken as one-half of 100 lb.; *f* denotes the weight of the bridge per square foot at the springing line; and *H* is the horizontal component of the thrust.

TABLE 4.

(1)	(2)	ORDINATES AT:				(7)
$\frac{a}{f}$	$\frac{H}{l^2}$	(3) 0.4 *l*.	(4) 0.3 *l*.	(5) 0.2 *l*.	(6) 0.1 *l*.	Tan. *b*.
0.50	8.33	0.969 *f*	0.873 *f*	0.697 *f*	0.412 *f*	$5.00 \frac{f}{l}$
0.45	7.71	0.970 "	0.879 "	0.703 "	0.418 "	5.08 "
0.40	7.09	0.971 "	0.880 "	0.706 "	0.426 "	5.18 "
0.35	6.46	0.972 "	0.885 "	0.715 "	0.435 "	5.32 "
0.30	5.83	0.975 "	0.887 "	0.722 "	0.442 "	5.41 "
0.25	5.21	0.976 "	0.889 "	0.733 "	0.458 "	5.60 "
0.20	4.58	0.978 "	0.901 "	0.745 "	0.464 "	5.81 "
0.15	3.96	0.985 "	0.913 "	0.762 "	0.482 "	6.11 "
0.10	3.33	0.987 "	0.924 "	0.784 "	0.505 "	6.59 "
For Parabola.		0.96 "	0.84 "	0.64 "	0.36 "	4.00 "

The figures in Column 2, multiplied by the square of the span, in feet (and without any drawing whatsoever), gives the thrust, in pounds per linear foot of bridge. This line of pressure has the property that the maximum positive bending moments at the loaded side have the same values as the maximum negative moments at the unloaded side.

(2) Where the bending moment from concentrated loads is smaller than that caused by a moving uniformly-distributed load, it is common practice to calculate the arch for one-half the span uniformly loaded. The new line of pressure is lowered at the springing line of the loaded side a maximum distance, *m*, approaches the old line of pressure, and intersects it at a point one-eighth of the span distant from the abutment, remains above this line for the remaining portion of the half span, and intersects it at the crown, remaining below it until seven-eighths of the span is reached, and rises a maximum value, *m*, at the abutment of the unloaded side. The exact vertical deviations of the new line of pressure can be obtained very simply, as shown in Fig. 4. Over each half span is drawn a parabola, the rise of which is $m = \frac{wl^2}{64\ H}$, in feet; in which H is the horizontal component of the thrust, in pounds, from dead load and half of the live load uniformly distributed; l is the span, in feet; and w is the uniform live load per square foot, or per linear foot in case of ribbed arches. $A\ D$ and $B\ E$ are made equal to $\frac{wl^2}{64\ H}$, and then the line, $D\ E$, is drawn. The verticals of the shaded areas are the vertical deviations of the pressure line. Those which lie above $D\ E$ have to be taken as the rise of the new pressure line, and those below that line indicate a lowering of the pressure line. It is easily found that the maximum deviation, except at the springing line, occurs at a point five-sixteenths of the span distant from the abutment, and is equal to $\frac{9}{16} \times \frac{pl^2}{64\ H}$; or, the greatest bending moment is $\frac{9\ pl^2}{1\ 024}$, in foot-pounds.

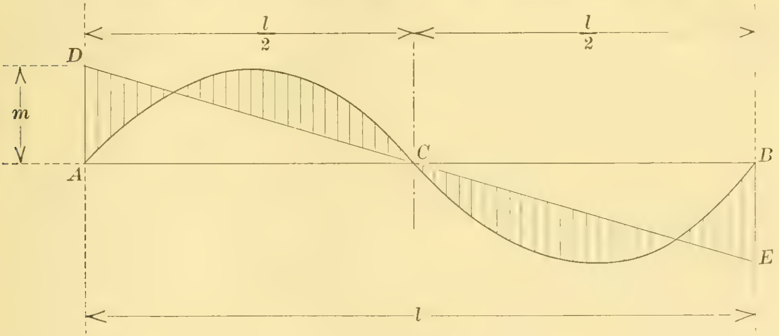

FIG. 4.

Mr. Mensch. As the stresses can be found from the bending moment, it is not necessary to draw the diagram, Fig. 4, or to show the change of the line of pressure in the elevation of the arch. Most of the concrete and stone bridges which have been built during the last twenty-five years were designed by this method.

(3) The change of the line of pressure produced by a group of concentrated loads cannot be found by any other method than that of the elastic theory. Methods* applicable to this case do not offer more difficulty than those used for simple beams. The busy engineer, however, will welcome a table of equivalent uniform loads to be applied on the half-span of the arch, which will produce the same maximum deviation of the line of pressure as a group of concentrated loads. For a 10-ton wagon, according to Cooper's Specifications, the equivalent loads per square foot may be found from Table 5.

TABLE 5.

Span, in feet	30	40	50	60	70	80	90	100	110
Load, per square foot	265	205	170	160	150	137	125	114	109
Span, in feet	120	130	140	150	160	170	180	190	200
Load, per square foot	104	97	91	85	82	78	74	71	68

For heavier wagons, the uniform loads may be increased in proportion.

(4) The effect of the shortening of the arch is very small in properly designed reinforced concrete arch bridges, and, as a rule, can be neglected, except where the rise of the arch is one-eighth of the span or less, and especially where ribbed arches are used. The effect of the shortening of the arch on the line of pressure when one-half of the span is loaded, is to elevate it at the crown a distance, $c = \frac{1}{3} \times \frac{d^2}{f}$, in feet, and to lower it at the springing line of the loaded side a distance, $c_1 = \frac{11}{12} \times \frac{d^2}{f}$, where d equals the depth of the arch or arch ring at the crown, in feet, and f equals the rise of the arch, in feet.

For example, assume a 140-ft. arch of 25 ft. rise, and having a thickness of 2 ft. at the crown; $c = \frac{2^2}{3 \times 25} = 0.0533$ ft., and $c_1 = \frac{11}{12} \times \frac{4}{25} = 0.1467$ ft., which are very small values.

When both halves of the arch are uniformly loaded, c remains $= \frac{1}{3} \times \frac{d^2}{f}$, while $c_1 = 2\ c$.

Inasmuch as the dead load, as well as the live load, will cause a shortening of the arch, it follows that it is, strictly speaking, impossible

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* In the "Reinforced Concrete Pocketbook."

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to design an arch in which the line of pressure coincides with the center of gravity of the sections, and that there is always a deviation from the ideal line of pressure.

In the case of the 190-ft. arch of the Almendares River Bridge, $c = \frac{5.5^2}{3 \times 32.5} = 0.31$ ft., and $c_1 = \frac{11}{12} \times \frac{5.5^2}{32.5} = 0.85$ ft., which is about twice the deviation of the line pressure caused by the live load alone.

The bending moment due to the shortening of the arch equals the horizontal component of the thrust multiplied by c; or, taking the value of the thrust from Fig. 4, $1\,250\,000 \times 0.31 = 387\,500$ ft-lb. at the crown, and $1\,250\,000 \times 0.85 = 1\,060\,000$ ft-lb. at the springing line. While the first value is about as great as the bending moment produced at five-sixteenths of the span from the live load, the value at the abutment is considerably greater than the bending moment produced by the live load direct. From the paper it does not appear that the authors took the effect of the shortening of the arch into consideration, as in this case the line of pressure will deviate at the crown from that obtained by the static theory.

The stresses produced by the moment at the abutment =

$$\frac{1\,060\,000 \times 12}{54 \times \frac{102^2}{6}}, \text{ or } 136 \text{ lb. per sq. in.}$$

In the case of a solid arch having a thickness of 3 ft. 6 in. and 5 ft. 3 in. at the crown and abutment respectively, $c = 0.0796$ ft. and $c_1 = 0.29$ ft., or a stress of 122 lb. per sq. in. at the springing line.

(5) The effect of a change of temperature is very similar to the effect of the shortening of the arch. Let t = the change of temperature, in degrees Fahrenheit; e = the coefficient of expansion for 1° Fahr., generally taken as 0.0000050; I = the moment of inertia of the crown section; f = the rise, in inches; and E the modulus of elasticity. Then the change of the thrust, $\Delta H = \frac{45\, E\, I\, e\, t}{4\, f^2}$.

If this thrust is supposed to act in a horizontal line at a height of $\frac{2}{3} f$ above the intersection of the line of pressure with the abutment, as shown in Fig. 5, the leverages of the moments produced by the change of thrust can be scaled off for every point of the arch. The latest practice assigns to E a value of 1 500 000, and to t a value of 40° Fahr.; hence

$$\Delta H = \frac{45}{4} \times 1\,500\,000 \times 0.000005 \times 40 \frac{I}{f^2} = 3\,375 \frac{I}{f^2} \text{ lb.},$$

which means an increase of thrust for a rise of temperature, and a decrease of thrust for a fall.

The greatest moment from a change of temperature occurs at the springing line, and is $2\,250 \frac{I}{f}$ in-lb.

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At the three-tenths point of the arch, where the greatest stresses from the live loads usually occur, the bending moment is $584 \frac{I}{f}$ in-lb.; at the crown it is $1\,125 \frac{I}{f}$.

For example, take the 140-ft. arch, of 25 ft. rise, and 24 in. thick at the crown. $I = \frac{12 \times 24^3}{12} = 13\,824$ in-lb., $f = 300$ in., and $\varDelta H = 3\,375 \frac{13\,824}{300 \times 300} = 518$ lb., which produces a uniform pressure of less than 2 lb. per sq. in. at the crown.

The moment at the crown $= 518 \times \frac{25}{3} = 4\,320$ ft-lb., which would influence the design of the arch if the greatest bending moment from the live load would occur at the crown. At the three-tenths point of the arch the bending moment from a change of temperature $= 584 \times \frac{13\,824}{300} = 26\,800$ in-lb. The maximum stresses at this section, assuming the thickness of the arch to be 27 in., $= \frac{26\,800}{12 \times \frac{27^2}{6}} = 18.4$ lb. per sq. in.

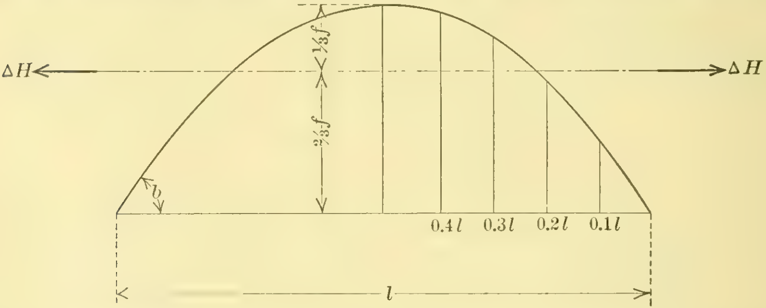

FIG. 5.

At the springing line the moment $= 518 \times \frac{2 \times 25}{3} = 8\,640$ ft-lb., and maximum stresses $= \frac{8\,640 \times 12}{12 \times \frac{36^2}{6}} = 40$ lb. per sq. in.

For the 190-ft. ribbed arch, I is approximately $1\,290\,000$ in-lb., $f = 390$ in., and $\varDelta H = 3\,375 \times \frac{1\,290\,000}{390 \times 390} = 28\,700$ lb., or about 8 lb. per sq. in. The moment at the crown $= 28\,700 \times \frac{1}{3} \times 32.5 =$ 311 000 ft-lb. The moment at the abutment $= 28\,700 \times \frac{2}{3} \times 32.5 =$

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622 000 ft-lb. The moment at the three-tenths point of the arch $= 548 \times \frac{1\,290\,000}{390} = 1\,935\,000$ in-lb., corresponding to a stress of only 38 lb. per sq. in. Similarly, the maximum stresses at the springing line are 78 lb. per sq. in.

For a 190-ft. solid arch, $\Delta H = 14\,700$ lb., and the maximum stresses at the springing line are 52.8 lb. per sq. in.

As pointed out by George S. Webster and Henry H. Quimby, Members, Am. Soc. C. E., in their valuable paper on the Walnut Lane Bridge in Philadelphia,* the actual change of temperature of the concrete and the accompanying rise and fall of the arch depend on the mean weekly temperature, or probably the mean monthly temperature; and, while the highest and lowest temperatures of the air during their observations varied between 95 and 10°, the corresponding temperatures of the mass of the arch were 73 and 31°, a change of only 42° Fahr. When the concrete of the arch is completed at a time when the mean weekly temperature is about the mean of these values, a change of temperature of only about 20° may be assumed, and the stresses above given are reduced to one-half.

The change of elevation at the crown due to a change of temperature of 40° can be found according to the elastic theory if the moments shown in Fig. 5 are used in the formula for deflection, and is equal to $\frac{1}{11\,700} \times \frac{l}{f} \times L$, and this theoretical value, contrary to the statement of the authors, agrees very well with the observations from quite a large number of important bridges built in voussoirs, both in America and abroad.

(7) The deflection of the crown of the arch due to the dead load and uniformly distributed live load, $\Delta f = \frac{17}{64} \times \frac{l}{f} \times L \times \frac{s}{E}$, in feet, where L is the developed length of the arch, in feet, and s is the compressive stress of the crown section.

For $s = 250$ lb. per sq. in., $\Delta f = \frac{1}{22\,600} \times \frac{l}{f} \times L$.

The deflection from a uniformly distributed load over the whole arch can be found by the same formula, if for s is substituted the additional stress caused by the load; and, when only one-half of the span is loaded, the deflection of the crown is one-half of the value obtained for the full load.

For a point distant five-sixteenths of the span from the abutment, the deflection produced by a uniform load on the half span $= \frac{1}{24\,000} \times \frac{pl^4}{E\,I}$.

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* *Transactions*, Am. Soc. C. E., Vol. LXV, p. 423.

Mr. Mensch. (8) The effect of shrinkage on the line of pressure is a subject on which very little can be found in the literature on concrete arches. Very careful tests made on small and medium-sized concrete specimens show that the effect of shrinkage after 1 month is the same as a fall of temperature of 60° Fahr., and that after from 3 to 6 months the effect of the shrinkage is the same as a fall of 100° Fahr., which would mean that the stresses in the arch at the time when the centering is struck are about one and one-half times the stresses given under Section (5) for a change of temperature of 40°, and that these stresses increase to two and one-half times those values after from 3 to 6 months. While these stresses may exist in bridges having a thickness of only a few inches, they do not exist in arches even only 12 in. thick, which has been found by the writer by the following observation. In a number of bridges the centering did not settle after the arch ring was completed, nor was the slightest movement of the abutment observed. After the centering had been struck and the deflection of the crown had been carefully observed for a period of a month or two, the deflection was computed for dead loads, according to Section (7), and for a change of temperature, as given in Section (5). The remaining deflection must have been due to the shrinkage of the concrete, and, in one instance, was found by the writer to amount to only six-tenths of that obtained for a change of 40° Fahr.

The fact that the shrinkage of large masses of concrete is considerably less than shown in small test specimens is borne out by the experience of the authors when they state that the struts, having a length of about 306 ft., showed a shrinkage of only $\frac{3}{16}$ in., or only about $\frac{1}{19\,500}$ of the length.

(9) The effect of spreading of the abutments on the line of pressure is identical with the effect of a fall of temperature. A fall of temperature of 40° corresponds to a spreading of the abutments of $\frac{1}{5\,000}$ of the span. In the 190-ft, span, the spreading of Pier No. 3 amounted to $\frac{9}{16}$ in., or $\frac{1}{4\,000}$ of the span, corresponding to a stress 25% greater than for a fall of 40° Fahr., or to 98 lb. per sq. in. at the springing line. For a solid arch having a thickness of 5 ft. 3 in. at the abutment, the maximum stresses caused by the spreading of the foundation at the springing line would amount to 66 lb. per sq. in.

(10) The relative lowering, $\Delta\, y$, of one abutment in reference to the other, causes at the springing line a stress equal to $\frac{E\, d_1\, \Delta\, y}{l^2}$ in pounds per square inch, where d_1 is the depth of the arch at the abutment, in inches.

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In the 190-ft. arch, Δy was $\frac{9}{10}$ in., $d_1 = 102$ in., or the maximum stresses $= 1\ 500\ 000 \times \frac{102}{190 \times 12 \times 190 \times 12} \times \frac{9}{10} = 26.8$ lb. per sq. in.

In the case of a solid arch, the stresses would amount to only 16.6 lb. per sq. in.

In any arched bridge it is clearly of the utmost importance to make careful investigations to determine the horizontal and vertical movements of the abutment at the springing line before the final design of the bridge. These investigations should include tests of piles and test loads on the ground; and, from settlement under the future unit loads, a foreknowledge of the movement of the abutment can be obtained.

(11) From the foregoing it clearly follows that, in bridges having a comparatively low rise, or in arches having deep ribs, many of the stresses are directly proportional to the moment of inertia of the crown section; and, while ribbed arches may appear to be more favorable for the live-load stresses, the stresses from the shortening of the arch, from a change of temperature, from the shrinkage of the concrete, and from a settlement and spreading of the abutments, are far greater than in a solid arch, and bridges with insecure foundations, like the one described in the paper, should certainly have been built with solid arches; or, preferably, a reinforced concrete arch should have been used.

The adoption of a three-hinged arch was quite unnecessary in this case, as the greatest stresses at the springing line of an arch without hinges would have amounted to only 669 lb. per sq. in., namely:

Direct compression from the thrust	260 lb.	(260)
Positive or negative stress from the live load	70 "	(92)
Positive or negative stress from the shortening of the arch	136 "	(122)
Positive or negative stress from a change of temperature (a change of temperature of only 20° was assumed)	39 "	(26)
Negative stress from the shrinkage of the concrete (assumed to be 50% of the effect of the change of temperature of 40°)	39 "	(26)
Positive or negative stress from a spreading of Pier No. 3	98 "	(66)
Positive or negative stress from the settlement of the pier	27 "	(17)

Or a maximum positive stress of 669 lb. per sq. in.

And a maximum negative stress of 155 lb. per sq. in.

This could easily have been taken care of by a small enlargement of the ribs at the springing line, or by a small amount of steel rein-

Mr. Mensch. forcement. It is thereby clearly shown that the line of pressure was outside of the middle third, and that the stresses which are ordinarily neglected, but which can be calculated in such a simple way, are of vital importance in the design of concrete arches, and while a small spreading of the abutments might easily increase the negative stresses in a concrete arch to a point where the concrete cracks, a reinforced concrete arch will allow a much greater abuse before unsightly cracks can appear.

In a solid arch having a thickness of 5 ft. 3 in. at the springing line, the greatest positive stress would have been 609 lb. per sq. in. and the greatest negative stress would have been only 89 lb. per sq. in.

The writer questions whether the hinges in the 190-ft. arch really acted as expected. All the influences above mentioned cause a considerable change of angle, both at the crown and at the springing line, and these evidently must have produced a considerable leverage of the thrust at the contact surfaces. The authors state that the changes in the hinged opening of the large arch were about $\frac{1}{16}$ in. It seems to the writer that this change of a total of about $\frac{1}{8}$ in. might have been distributed over the whole span in an arch without hinges with only a small additional stress.

A change of $\frac{1}{16}$ in. at the edge of the concrete section corresponds to a change of $\frac{1}{40}$ in. at the edge of the 2-in. cast-iron plate, or to a stress of 60 000 lb. per sq. in., which the concrete in contact with the edge evidently could not carry, and there must have been a local pulverizing of the concrete.

Mr. Strickler. G. B. Strickler, M. Am. Soc. C. E. (by letter).—As stated by the authors, the construction of the Almendares River Bridge was begun in November, 1908, and, prior to the middle of June, 1909, the pile-driving for the piers and struts was done, the concrete struts built, and the concrete for the south abutment and Piers Nos. 1, 2, and 3, carried up to Elevation 22.87. At this point the writer, as Resident Engineer for Messrs. Barclay Parsons and Klapp, took charge of the work.

The forming for the ribs, sheathing, and diaphragms for Arch No. 1 was then about completed, and the concrete work on this arch was begun on June 30th. The supporting framework for the centering was well done and the lagging properly laid, but the side forms for the ribs were set up and wired and nailed in place, and, on pouring the concrete, these side forms could not be kept in line, and the bulging noted by the authors resulted. The wiring was eliminated for similar work in Arch No. 2, but too much dependence was placed on nailing, rather than bolting, and the results were again unsatisfactory. These details were improved in the case of the other arches, and for the ribs of Arch No. 4 and the exterior walls built thereafter, Mr. Strickler.

bolts were used, passed through cement sleeves, which admitted of their removal later. This was accepted in lieu of the specification requirement which provided for sleeve nuts with ends placed not closer than 3 in. to exposed surfaces, the holes being pointed up with mortar after the removal of the bolts.

The cement sleeves were fairly satisfactory, but, owing to the variation in color between their exposed ends and the surrounding concrete, together with the difficulty in moulding the ends of the sleeves truly normal to their length, and later placing them in the same plane with the exposed surfaces, the sleeve nuts as specified are much to be preferred.

On this work, as is often the case, it was difficult to secure a thorough study and detailing of the form work prior to its construction. It has been the writer's experience that such conditions lead to added expense as well as unsatisfactory work, and in writing specifications for concrete work, it would probably be difficult to lay too much stress on this feature. In the average case the services of an experienced and capable draftsman would not amount to more than 2% of the pay-roll expense, and to say that 10% could thus be saved is believed to be conservative. When this is supplemented by a well-designed construction plant, much has been done toward reducing the cost of modern concrete work.

The concrete, as well as the form work, was improved as the work progressed. The authors have referred to the stone, which, owing to the numerous clay-filled cavities, was difficult to wash and prepare for use. These water-worn cavities, prior to crushing, were from 1 in. to 1 ft. or more in diameter, and those operating the crusher plant had difficulty in securing a proper selection and cleaning of the stone before crushing. When the stone was crushed, most of the clay, if dry, went into the finer sizes, and, therefore, these were necessarily excluded from the work. As a matter of interest, some of the screenings were washed and found to contain 30% of clay.

The concrete in Arch No. 1 probably contains from 12 to 13% of clay. It is believed that the clay in the concrete of Arch No. 2 does not amount to more than from 7 to 8%, with some further improvement in the later work. At the beginning of the arch construction a barrel filled with water was kept near the super-hopper containing the stone just prior to its being drawn into the mixer, and before being used several bucketsful were thrown over the charge and allowed to drain off. This was unsatisfactory, and two perforated pipes were laid on the sloping bottom of the hopper. These, as well as a jet pipe, were connected with a steam pump which gave a pressure at the outlets of about 20 lb. per sq. in. The valve controlling the perforated pipes was opened when beginning to fill the hopper, Mr. Strickler. and, after filling, the jet pipe was used and the washing continued until the water draining off was reasonably clear.

When the forms were removed from the ribs of Arch No. 1, it was found that in three places, where leaks had occurred, voids in the stone were unfilled. On careful investigation these planes (almost truly horizontal) were found to extend into the work 2 ft. or more. These sections were cut out and replaced, and this operation showed clearly the effects of the clay. Such planes of weakness near the springing of an arch would be particularly hazardous. The concrete in Arch No. 1 was studied closely during the ensuing year, and was found to harden less rapidly than that containing less clay.

In placing concrete in work of this character, where the concrete is made quite wet and there is an interval of 1 min. or more between batches, great care should be taken, after depositing each batch, to spade or otherwise work it deep enough to make sure that it will be well mixed with the batch below. This will also tend to bring the light inert parts to the top, where they will remain or run off with the excess of water; and, in cases where the top of the form is not reached within a day's work, they may be cleaned off before resuming work.

The 2-in. pipes through the lower edges of the diaphragms, just above the soffit sheathing, were found to be entirely too small; not that they failed to pass the water when they were open, but, being so small, they were easily clogged. A diameter of 2 in. would be ample for the openings through the sheathing adjacent to the piers and abutments, as they could be opened readily from the ground in cases of stoppage, but, through the diaphragms, such openings should be not less than 8 in. in diameter, and larger ones would be even better. It is also believed that, for constructional reasons, diaphragms deeper than 3 ft. should be not less than 12 in. thick.

In building columns, the writer has found that the best results are obtained by not filling them too rapidly. By putting in 2 ft. at a time, with about 15 min. between successive fillings, time enough is provided for rodding it well and stopping any leaks which may have developed. The leaks must be looked after closely, and, after stopping, in each case, the concrete should be again rodded to insure the refilling of any voids.

In building ribbed arches such as those under discussion, the writer is strongly of the opinion that no arch action should be permitted in any of the ribs of a given arch until all are built and made ready for the keying. This was particularly desired in the 190-ft. span of the Almendares Bridge, but the work was done during the season when freshets are to be expected, and the contractor was afraid of the risk. The author's reference to the lipping of the sheathing concrete adjacent to the older ribs, clearly shows that, to some extent, Mr. Strickler.

they were off the centering. Ribs built and keyed as this arch was, from the longitudinal center outward, are undoubtedly favorable to the centering, increasing as the arch action in the older ribs is developed; but, in addition to the possible harm done the concrete, is not the arch to some extent "center bound"?

Referring to the tell-tales or observation points used in connection with the rib construction of all arches, it should be noted that these were all established over the respective arches prior to beginning the concrete work, and were carried by the lagging. The lagging was particularly well laid over properly curved joists, but when the concrete was laid, say, from the longitudinal center outward, it was found that the lagging raised somewhat at the ends after being weighted at the center, which accounts for most of the plus readings obtained.

The centers were all struck from haunch to crown, first lowering from $\frac{1}{4}$ to $\frac{3}{8}$ in., symmetrically, that is, in similar bents at the same time, until the crown was reached, and this was repeated until well clear of the concrete. Attention is called to an inadvertent statement to the effect that the centering was struck before laying the concrete in an adjacent arch. The order in which this was done may be noted by reference to the remarks on Table 2, where it will be seen that Arch No. 2 was completed on 8-17-09, and the centering under Arch No. 1 was struck on 9-29-09. Arch No. 3 was completed on 11-10-09, and the center under Arch No. 2 was struck on 11-25-09. The two central ribs of Arch No. 4 were completed and keyed on 2-20-10, the next two on 3-6-10, and the center under Arch No. 3 was struck on 3-8-10.

The plans and details for this work were well and carefully made, and the specification was practical, fair, and brief, but well to the point.

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AMERICAN SOCIETY OF CIVIL ENGINEERS

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PAPERS AND DISCUSSIONS

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SOME OF THE PROPERTIES OF OIL-MIXED PORTLAND CEMENT MORTAR AND CONCRETE.

Discussion.*

By Messrs. S. D. Newton, T. S. Oxholm, Lars R. Jorgensen, H. de B. Parsons, Frank J. Phelan, Clifford Richardson, R. D. Coombs, and Maurice G. Parsons.

Mr. Newton.

S. D. Newton, Assoc. M. Am. Soc. C. E. (by letter).—It seems to the writer that Mr. Page's experiments on oil-mixed mortar and concrete, fragmentary and incomplete as he himself confesses them to be, open up a very useful field of knowledge to the engineer, and go far toward solving the problem of water-proofing concrete structures. The possibilities of further experimentation are almost unlimited, and it is to be hoped that some one with ample funds and facilities at his command will take hold of the matter at once. As the first credit undoubtedly belongs to Mr. Page, all will agree that he is the one to follow the matter up, if it can be arranged; and the writer would be in favor of memorializing Congress to make an appropriation placing funds at the disposal of the Public Roads Department for this purpose.

Mr. Page's conclusions are based on experiments with some eight samples of mineral oils, and, for each test, his results are based on breaking only one or two specimens of concrete or mortar mixed with each oil. It is not likely that the breaking of a larger number of specimens would alter the results materially, but, nevertheless, the conclusions

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* This discussion (of the paper by Logan Waller Page, M. Am. Soc. C. E., published in *Proceedings* for September, 1911, and presented at the meeting of November 1st, 1911) is printed in *Proceedings* in order that the views expressed may be brought before all members for further discussion.

In the *Proceedings* of this Society, the Papers and the Discussions on Papers will hereafter be printed so that each will commence on an odd-numbered page. This is done by special request, in order to enable members who wish to do so to separate the Papers and Discussions for filing under various engineering subjects.

Mr. Newton. would have been more convincing if three or more times the number of tests had been made with each of these individual oils. Also, if a wider range of oils and concrete materials had been used, it would have been possible to determine closely what kind or class of oil is most efficient and cheapest in the long run for the purpose, as, for instance, between oils having a paraffin or an asphaltic base, and of different degrees of refinement.

It is generally conceded that animal oils tend to disintegrate concrete; but, as far as the writer knows, this conclusion is based on repeated external applications of such oils (as, for instance, spigot droppings of "signal oil" on concrete floors), and not on studies of oil-mixed concretes, such as those made by Mr. Page. Experiments along this line would be highly illuminating, as would also experiments with linseed, cottonseed, and other vegetable oils incorporated in concrete. Ferro-Portland cements are coming into use for structures subject to the action of salt water; it would be interesting to know in what way, if at all, oil-mixing would affect them, and whether the results would differ from those which obtain with ordinary cements.

A series of long-time tests (extending over two or three years or more) should be started at once to determine whether or not the water-proofing effect of oil-mixing is permanent, and what proportion of the observed decrease in crushing strength, as between oil-mixed and ordinary concrete, remains at the end of the longest period of the test. Accelerated tests could, perhaps, be devised in order to give at once some little knowledge as to the permanence of the water-proofing. Tests to determine the chemical reactions are also desirable. It is probable that a certain part of the cement unites with the oil to form an emulsion, but why this should not decrease the tensile strength (for instance) in something like the same proportion as it does the crushing strength, is a point which has not yet been made clear.

As to the service tests described by Mr. Page, these, too, are instructive, but as none of the structures mentioned is yet 18 months old, it is too early to draw sweeping conclusions as to their ultimate behavior. The writer has had some little experience along the line of concrete pavements, and he must confess that he is skeptical as to the advantage of oil mixtures for that purpose. His observations go to show that it is not so much the absorbing power of the concrete which causes failure, as it is the cracking due to contraction during cold weather; nor can he see how an admixture of oil would tend to add anything to the elasticity of the surface or make the pavement easier on draft animals.

Mr. Page's action in throwing his patent open to the use of the general public cannot be commended too highly, and the writer believes that all inventions, of use to engineers, should be treated in the same way.

Mr. Oxholm.

T. S. Oxholm, M. Am. Soc. C. E. (by letter).—In the latter part of 1909, the writer met Mr. Page at a convention of cement manufacturers, and became interested in the paper which he read at that meeting describing certain experiments which he had made with mortar mixed with oil.

An offer was subsequently made by the President of the Borough of Richmond to the United States Department of Public Roads to experiment with oil concrete under Mr. Page's direction, as it was understood that that Department had no funds with which to carry on experiments of this character.

In the summer of 1910 arrangements were completed, and a stretch of pavement, of about 1 500 sq. yd., was laid on Innis Street, Borough of Richmond. This piece of pavement is referred to in the paper, and as the experiment was made under the joint control of Mr. Page and the writer, a few details may be of interest. A number of tests of briquettes of this material were made in the laboratory of the President of the Borough of Richmond, which, compared with the tests made by the author, agreed remarkably well and indicated that the proper quantity of oil would be 15% of the weight of the cement.

When the mixing was first started, an attempt was made to follow the method recommended by the Department of Public Roads, viz., that the cement and sand should be placed in the mixer and enough water added to make a stiff mortar, after which the oil should be added and mixed, then the stone placed in the machine, and the whole mass thoroughly combined. A "Ransome" batch mixer was used for the concrete, but, in attempting to follow the method outlined, it was found that the oil stuck to the surface of the mixer, and would not combine thoroughly with the mortar.

The method finally adopted was to place the sand and cement in the machine, and, after mixing, add as much water as was necessary to bring the complete batch to the proper consistency. The quantity of water was determined by trial, and was sufficient to make a thin mortar. Then the oil was added, the dampened stone was dumped into the mixer immediately after the oil, and the whole mass was thoroughly mixed. With this method the oil quickly emulsified and combined intimately with the other materials.

The following is the report of Louis L. Tribus, M. Am. Soc. C. E., Consulting Engineer and Acting Commissioner of Public Works, to the President of the Borough, describing this experimental pavement, and including the reports of the assistant engineer, and the engineer in charge of the work:

"Pursuant to your authorization from time to time, we have experimented with every class of road pavement which seemed to promise to be of service in the Borough of Richmond and to meet

Mr. Oxholm. different conditions of grade, exposure, traffic, and development of the adjoining property.

"A year ago last spring it was deemed desirable to lay a specimen pavement of 'oil concrete.'

"The United States Director of Public Roads was interested in the subject, and assigned an engineer to be present during the laying of pavement which, except for a very small sample laid on a bridge in Ridgewood, N. J., was to be the first demonstration of the kind in the United States.

"The following reports, filed respectively by W. B. Grubbe, Asst. Engineer, in direct charge of the test, and Theodor S. Oxholm, M. Am. Soc. C. E., Engineer in charge of construction generally, give the salient points as to the original laying of the pavement and its condition after nearly fifteen months of service:

"'JULY 20, 1911.

"'Attached is a map of Innis Street, showing the limits of the various mixtures of oil concrete pavement laid in May, 1910.

"'The concrete was mixed in the proportion of one part cement, 2 parts sand, and 4 parts broken stone, ¾ in., with the addition of oil at the rate of 15% of the weight of the cement. With the Texaco oil an allowance was made for a 20% cut back.

"'The cement and sand was mixed and water added to form a mortar, after which the oil and then the stone was added. The whole mass was then thoroughly mixed and deposited on the street to form a wearing surface 4 in. in thickness. A mechanical mixer was used for the concrete. After spreading, the concrete was tamped, and after the initial set, was covered with sand.

"'I have made a recent examination of the pavement and found that the joint at the end of each day's work is very marked. The second day's work on the section laid with Vulcanite cement and Standard oil is fairly good, and also the 3rd. On the 4th day's work there are a number of small depressions, caused originally by throwing sand on the pavement before it was sufficiently set.

"'In the section laid with Giant cement and Standard oil, there are a great many small cracks.

"'In the section laid with Saylor cement and Texaco oil, a portion of the surface seems to be powdery. In this portion the surface was struck with a straight edge and floated.

"'The section laid with Edison cement and Texaco oil, has a few cracks in the first portion; the latter portion is fairly good.'

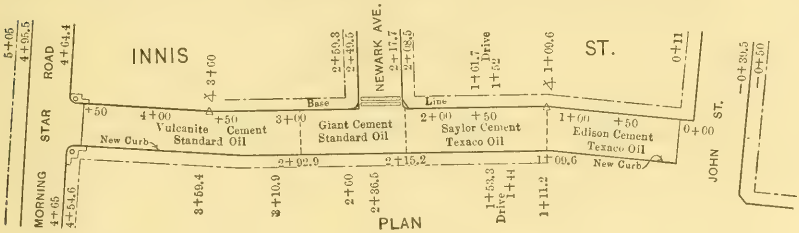
"'SEPTEMBER 13, 1911.

"'Herewith please find plan and report of Assistant Engineer in charge of the experimental work of repaving Innis Street, between John Street and Morning Star Road, with oil concrete pavement a little over a year ago.

"'The general effect of the pavement is poor, and this is largely due to the lack of knowledge as to methods of construction, this being the first piece of work of this character ever attempted in this country, except a very small sample in Ridgewood, N. J., on a bridge. It is believed that a much better piece of work than this could be done with the knowledge gained, both as to the materials to be used and the methods of laying and finishing each day's work. I do not think, however, that this class of pavement, after being 15 months in use, has shown sufficient merit to make it advisable for us to lay any more of it at the present time. Mr. Oxholm.

"'It will be remembered that this work was done under the supervision of the U. S. Bureau of Public Roads, Department of Agriculture, and an Engineer from that Department was at all times present on the work. The cement and oil were presented free of charge to the City for the purpose of experimentation, the City furnishing the other materials and a contractor doing the work under the supervision of this Bureau.'

"The sketch plan [Fig. 9] shows Innis Street with the general limits of the four sample pavements laid; one portion each being mixed with oil and Vulcanite, Giant, Saylor, or Edison cement.



PLAN
OF
AN EXPERIMENTAL PAVEMENT
OIL CONCRETE
LAID ON INNIS STREET
BOROUGH OF RICHMOND.

Fig. 9.

"The grade of the street is very moderate (1.4%), just sufficient for good storm flow.

"It may be possible with a more complete knowledge of the characteristics of road oils and certain brands of cement that success may yet be secured in pavements of such character; but we do not see from the test made sufficient promise of value to feel disposed to recommend any further work along that line here."

For the information of any one desiring to inspect this pavement, it may be easily reached by the New York Ferry to St. George, and the North Shore train to Elm Park Station; Innis Street is one block south of the station.

Lars R. Jorgensen, Assoc. M. Am. Soc. C. E. (by letter).—For some reason or other the writer had thought that oil and concrete would not work well together. The tests made by Mr. Page, therefore, were a surprise to him, as they seem to show conclusively that, within certain limits, the oil does not weaken the concrete, or only affects it to a small extent. Mr. Jorgensen

Mr. orgensen.

The practical applications of this oil-mixed concrete may be very extensive. For the writer, it has most interest when used in dam construction for the purpose of making a tight dam. A few feet next to the up-stream face built of oil-mixed concrete should act as a good water-proofing. To build the whole structure of oil-mixed concrete would not seem to be practical, because, in order to keep the value of the modulus of elasticity high with oil-mixed concrete, it would require a richer mixture than ordinarily used (if future tests on completely aged specimens do not show different results); besides, the oil adds to the cost, and makes the concrete slow-setting—too slow for many cases of dam building, where the load must be taken up almost as soon as the structure is completed.

When used in connection with arch dams, it is of great advantage that the permanent set of oil-mixed concrete (not the possible shrinkage due to setting, but the permanent deformation after the reservoir has been filled once) is less than that of ordinary concrete. This is seen to be true for 1:3:5 concrete or richer, and a leaner mixture should not be used for a water-tight face. When the reservoir is empty, after having been filled at least once, and no vertical cracks have appeared on the arch, it is clear that, if the permanent deformation is smaller for the lining of oil-mixed concrete on the up-stream face than for the ordinary concrete in the remainder of the dam body, axial compression will exist along the up-stream face, tending to close any cracks which otherwise might open, even if the remainder of the structure is not stressed, or is a little in tension.

Why just the opposite is the case for a 1:3:6 mixture, and the permanent deformation of oil-mixed concrete is larger than for ordinary concrete (according to the tests, four times larger), is somewhat of a mystery. There may be a point where conditions reverse, but this seems to take place too abruptly. Possibly the specimen used was too green (28 days) considering the leaner mixture, but, if this proportion will still hold for completely aged concrete, it simply goes to show that oil-mixed concrete leaner than 1:3:5 cannot be used to advantage for dam facings. It will be interesting when tests have shown the relative value of the permanent deformation of oil-mixed and plain concrete for specimens from 2 to 3 years old, that is, after complete aging. Possibly then the law followed by the different mixtures in regard to permanent deformation may be found, from which information can be obtained as to what mixtures should not be used for certain structures.

Mr. H. de B. Parsons.

H. DE B. PARSONS, M. AM. SOC. C. E. (by letter).—The writer is interested in this paper, especially as he used oil-mixed mortar in the erection of a building in 1905. The building was much exposed to the weather and winter storms, and was constructed of brick and

Mr. H. de B. Parsons.

wood. Where the different kinds of construction joined, copper flashing was used.

In order to make tight joints between the vertical edges of the copper flashing and the brickwork, he used Portland cement mortar mixed with oil. A coating of this oil-mixed mortar was placed on the brickwork, and, while soft, the copper sheets were laid over it and fastened. Then the cement was forced under the edges of the copper in order to caulk any opening that might be left. Although exposed to the north, east, and west, these joints have remained tight.

The builder who did the work, stated that on previous jobs he had used oil in mixing cement mortar in order to make effective water-tight joints.

Mr. Phelan.

FRANK J. PHELAN, ESQ. (by letter).—Logical engineers build for the future, and incline to the use of concrete on account of its greater commercial economy and permanency. The chief objection to its use for many purposes is its well-known porosity and capillarity. Below grade, a concrete wall becomes water-soaked, and, if above grade, under the influence of the elements, efflorescence appears on the surface and changes its appearance, thus condemning it artistically. To control this condition there is no remedy except to water-proof the mass by an integral method, and this is the aim of this paper.

Is mineral oil a safe and logical water-proofer? A mixture of 1:3, composed of 100 lb. of cement, and 300 lb. of sand, requires 70 lb. of water to temper the mortar properly. According to the standards, this mass when dry weighs only 425 lb., showing that the cement in crystallizing takes up in combination only 25 lb. of water, and the remainder (45 lb.) evaporates, leaving 10% of cell space, which water will again enter if supplied. Concrete mixes are sometimes graded to show 25% absorption. This problem, however, the busy architect or engineer is asking the chemist to solve by suggesting a water-proofing unit to mix with cement which will compensate for this physical action, to the end that, under the operation of a natural law, the capacity of the cement for absorbing moisture will be changed from positive to negative, so that water will not again penetrate the finished wall; and they naturally stipulate, further, that the tensile strength of walls thus treated must not be diminished. A foreign substance, whether it does or does not water-proof is not admissible, but a water-proofing unit composed chiefly of the principal elements of cement, calcium base, which when added in small quantity will not arrest or interfere with the natural cementitious processes, but will form a basic insoluble compound in itself, is admissible; and it is such a unit that architects and engineers are expecting cement chemists to place at their command. This, if it could be secured, is an ideal, and will meet the objection so generally heard as to the use of

Mr. Phelan. cement for residential purposes. Compare such a standard with the use of mineral oil in the ratio of 10% of the weight of the cement, and at first flush it would seem that this patented method is comparatively worthless, for the following reasons:

1st.—It hurts the tensile strength of concrete, and this is admitted;
2d.—A 10% quantity adds too much to the cost of a cubic yard of concrete;
3d.—Its use is too dangerous and questionable, on work of any magnitude, where unskilled labor is a necessary factor;
4th.—It is a foreign substance;
5th.—It is a hydro-carbon—uncontrolled—unaffected by the alkaline elements with which it is mixed; out of harmony; penetrating in character in the absence of moisture; and hence, when diffused through the wet concrete, it will penetrate it after moisture evaporates, thus leaving an oil-soaked mass.

It water-proofs if it can be held in suspension, but this is doubtful. There are cases where oils spread over concrete surfaces gradually destroy the cement bond and cause disintegration. Hydro-carbon oil put with dry cement ruins it, as it kills crystallization. Its use can only be possible as a mix after the cement and other aggregates have been thoroughly manipulated with the tempering water, and even then it is admitted that the set and tensile strength are changed and lowered. If the water is not gauged accurately, and the mortar, instead of being stiff enough to hold the oil in suspension, is liquid, what will become of the oil? It will merely move with the water to the face of the forms, penetrate there and become lost, or find its way to a low point and run off. In a moderately stiff mortar for trowel use, manipulation with the trowel will cause the oil to follow the suction and collect on the surface; this is true with any substance which rides the water when introduced into the cement—any insoluble or fixed physical unit.

Hydro-carbon, non-drying, non-saponifying oil, is a dangerous element in concrete, and, to secure such water-proof results as this paper describes, requires knowledge of conditions and careful equative handling by expert labor. In a 1:3 mix, oil equal to 10% of the weight of the cement is equivalent to 2½% of the mass; in a 1:3:6 mix, it is 1 per cent. If a batch mixer is turning out ½ cu. yd. of concrete or more every 2 or 3 min., where will the oil be when the forms are filled? It will certainly be on the top, or side, or at the point of least resistance.

To water-proof cement logically, the water-proofing unit must be diffused uniformly throughout the mass, and must remain there. The writer submits that it is irrational, illogical, and dangerous to introduce into cement this foreign substance, mineral oil.

Mr. Richardson.

CLIFFORD RICHARDSON, M. AM. SOC. C. E.—The speaker has followed with interest Mr. Page's experiments with Portland cement mortar and concrete mixed with oil since their inception. These experiments arose from the observations of Allerton S. Cushman, Assoc. Am. Soc. C. E., that mineral oil could be emulsified with lime-water very readily, and that of Albert Moyer, Assoc. Am. Soc. C. E., that if this were the case a similar emulsion could be obtained with a Portland cement paste.

The results obtained by Mr. Page are very striking, and, no doubt, of considerable importance in certain directions. That a Portland cement paste or mortar will emulsify so readily a considerable percentage of mineral oil, is undoubtedly due to the free lime which is liberated on mixing the cement with water. The emulsion is so complete that it is impossible to distinguish particles of oil except under the microscope, and there is no possibility of a separation of the particles, when once emulsified, as has been suggested by one of the discussors. There is no possibility of the destruction of the bond of the Portland cement by the mineral oil, although this would happen very readily if a vegetable or animal oil were mixed with concrete, owing to the decomposition of the latter and the liberation of free acid, which would attack the lime of the Portland cement and destroy its bond.

A question has been asked as to the character of the oil which is suitable for use in oil-mixed concrete. Any of the denser oils, preferably more or less asphaltic, which are supplied by the Standard Oil Company, the Sun Company, the Texas Company, the Indian Refining Company, and the Barber Asphalt Paving Company, will be suitable for the purpose. The cost of the oil is only a few cents per gallon, and its use cannot add largely to the cost per cubic yard of concrete.

To the speaker it seems that the principal use of oil concrete will be in the form of an application of the material over structures built of ordinary concrete and to act as a water-proofing material. It is also worthy of note that many colloids will emulsify mineral oils in the same way as Portland cement.

At the Second International Road Congress, held in Brussels in 1910, a material, known as sand-clay asphalt, was exploited by Mr. Tardres, Engineer of Bridges and Roads at Algiers, some of it being laid on the exhibition grounds as a road surface. It is produced, according to the inventor, by mixing 12 parts of clay with a sufficient quantity of water (about 2 to 6 parts), and adding, while mixing, 12 parts of tar and 100 parts of hard sand. The clay paste emulsified the bituminous material with the same ease as the Portland cement paste emulsifies the oil, and it was eventually found that the clay

Mr. Richardson. could be replaced by any other colloidal matter mixed with water, such as dextrin. Such a mixture, as observed by the speaker, forms a very plastic mass, and can be readily spread or floated into place. It dries out rather slowly, but eventually becomes quite hard. The inventor claimed that it could be used very economically for binding together broken-stone roads, for walks, for cellars and stables, and for similar purposes.

At the same Congress a material was exploited under the name of "Kiton," by Dr. F. Raschig, of Ludwigshafen-on-Rhine, Germany, which is apparently of the same type—an emulsion of clay and tar rather than oil. A considerable quantity of this material has been used in Germany for road construction.

Mr. Page's method of making oil concrete can be advantageously modified by replacing a portion of the cement with clay. This makes a much more plastic and impervious mortar, it being well recognized that the addition of clay to a concrete makes it more impervious. Experiments in this direction have shown that there is no difficulty in making such a mortar, and that, when properly proportioned, it sets to an extremely hard mass and has a decided advantage over Mr. Page's straight oil cement concrete, particularly because of its impermeability, plasticity, and the ease with which it can be floated into place.

Mr. Coombs. R. D. Coombs, M. Am. Soc. C. E.—What are the merits of an oil mixture, as applied to the case of a beam or column continually exposed to moisture; a reinforced member with comparatively little concrete outside the reinforcement?

In other words, would an oil-mixed concrete protect the reinforcement from corrosion (in case corrosion were possible), from moisture entering the concrete by capillary action, assisted, perhaps, by small cracks due to bending, etc.?

To be more specific, assume that a concrete pole is located in a tidal marsh, where the concrete at the base is continually subject to the condition of alternate wetting and drying. Assume, further, that such a pole has 1½ in. of concrete outside the rods, that it may be subjected to more bending than usual in concrete structures, and that the design contemplates high unit stresses and concrete of a very high grade. Would there be any advantage in using the oil mixture in such a case?

Mr. M. G. Parsons. Maurice G. Parsons, Jun. Am. Soc. C. E. (by letter).—The experiments recorded in the paper demonstrate that the old fear of the harmful effects of oil in concrete is not entirely justifiable. Mr. Page has carried the work to a point where the desirability of further research is evident. At present any discussion of the subject by others

Mr. M. G. Parsons.

is likely to be rather of an inquisitive than supplemental nature. Four questions might be asked:

1. What effect on concrete will be produced by a change in the viscosity of any one oil?

2. How will oils of different viscosities influence concrete?

3. Will temperature, within practical working limits, produce, in and of itself, an appreciable result?

4. Can oils of widely different properties (such as crude, neat's foot, or machine) be relied on to give similar results?

These questions the writer cannot answer from a study of the paper, but they are fundamental in actual construction. Commenting on the first two, it may be remarked that:

1. The wide change, with temperature, in the fluidity of crude oil might give trouble.

2. An extremely fluid oil would possibly surround the cement particles and cause a serious loss of strength.

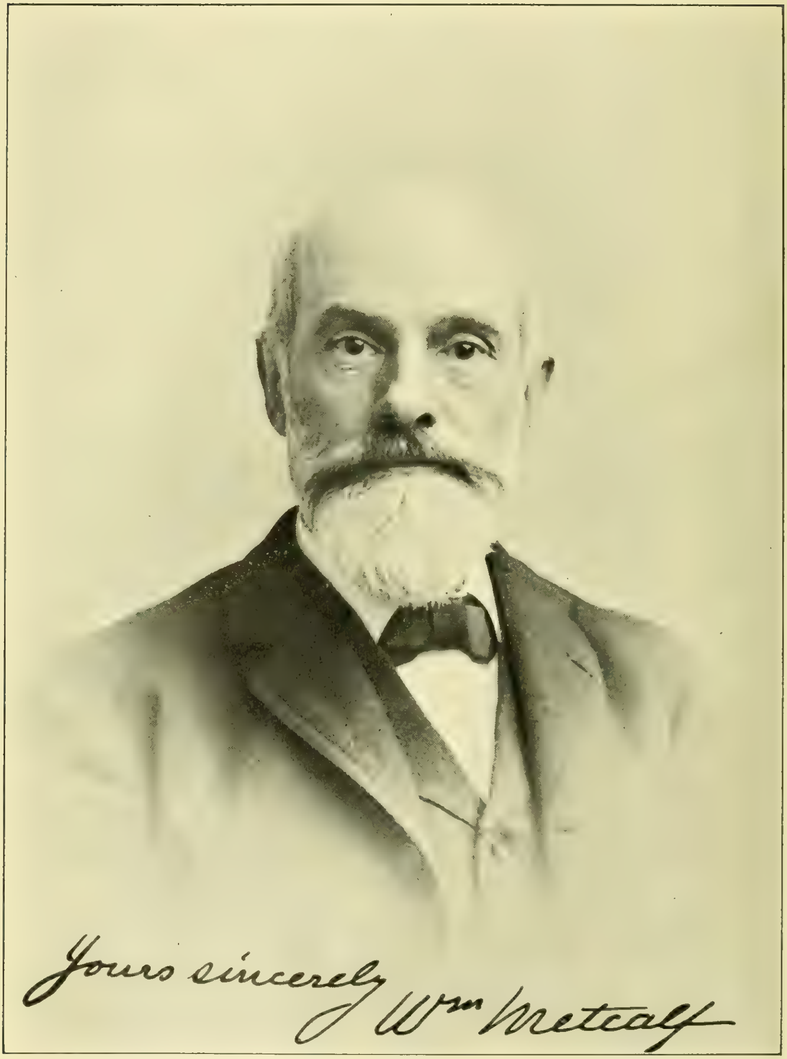
In view of the fact that the information regarding oil-mixed concrete is so incomplete, the writer would hesitate to use it without consulting Mr. Page.

Table 8, bearing on the foregoing questions, has been prepared from the information in the paper.

TABLE 8.

Crushing strength of water-cured concrete containing 10% of oil, at 28 days.	Oil.		Remarks.
	Viscosity.	No.	
1 710 lb. per sq. in.	2.5	4 981	5.25 times the tensile strength 1 : 3 months.
2 400 " " " "	6.4	4 146	1 : 3 months.
1 320 " " " "	14.2	4 145	1 : 3 months.
1 840 " " " "	17.4	5 053	5.25 times the tensile strength. 1 : 3 months.
1 720 " " " "	18.2	4 147	1 : 3 months.
1 750 " " " "	20.2	4 149	1 : 3 months.
1 740 " " " "	65.1	4 927	5.25 times the tensile strength. 1 : 3 months.

The factor, 5.25, in Table 8, was obtained by dividing the average crushing strength by the average tensile strength. The method of curing the tensile specimens is not known.



Yours sincerely Wm Metcalf

MEMOIRS OF DECEASED MEMBERS.

NOTE.—Memoirs will be reproduced in the volumes of *Transactions*. Any information which will amplify the records as here printed, or correct any errors, should be forwarded to the Secretary prior to the final publication.

WILLIAM METCALF, Past-President, Am. Soc. C. E.*

DIED DECEMBER 5TH, 1909.

William Metcalf was born at Pittsburg, Pa., on September 3d, 1838. His father, Orlando Metcalf, was an eminent lawyer of his time in Allegheny County, and was in partnership with Mr. Loomis under the firm name of Loomis and Metcalf.

In the fall of 1854 Mr. Metcalf entered Rensselaer Polytechnic Institute, and was graduated with the Class of 1858. After his return from college he was engaged as Superintendent in the Fort Pitt Foundry, of which his uncle, Charles Knap, was the principal owner. In addition to constructing what was known in those days as heavy machinery, the Fort Pitt Foundry was engaged, before and during the Civil War, in casting guns, mortars, and shells for the United States Government, the largest cast-iron guns ever made in the world being made there during that time, notably two 20-in. guns weighing 80 tons each.

In 1869 Mr. Metcalf bought an interest in the old firm of Miller, Barr, and Parkin, which became Miller, Metcalf, and Parkin, the partnership continuing until 1889, at which time the firm was incorporated as the Crescent Steel Company. The business of this company was that of making high-grade crucible steel, for tools and many special uses where quality counted for much. Late in 1895 he sold out his interest in this company, and, until 1897, was not engaged in active business.

In 1897, he organized the Braeburn Steel Company, and began the construction of the plant at Braeburn, which was put in operation during the summer of 1898. The business of this company is that of making high-grade crucible carbon steel and also open-hearth steel. Mr. Metcalf was President of this company and active in its affairs to the time of his death.

During his career as a steel maker he made a very careful study of the metallurgy of iron and steel, and had a thorough knowledge of the methods of manufacture, uses and treatment of steel. His book, entitled "Steel, A Manual for Steel Users," is regarded as a standard work on that subject.

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* Memoir prepared by the following Committee: Thomas H. Johnson, George Westinghouse, Jesse W. Walker, Emil Swensson, and Thomas Rodd, Members, Am. Soc. C. E.

Mr. Metcalf's peculiar knowledge of steel and its properties, and of the processes of manufacture, made him a valuable witness in many important cases in which patents were being litigated, and he was frequently consulted as an expert in that line.

In addition to his business career, he was a member of the Board of Arbitration which appraised the property of the Monongahela Navigation Company and awarded to that company more than $3 000 000. This award was accepted by both the company and the Government as a fair appraisal, and was paid by the United States for the property franchise of the company.

Mr. Metcalf was one of the founders of the Homeopathic Hospital, of Pittsburg, and was its President until his death. He was a lifelong member of St. Peter's Protestant Episcopal Church, and was its Senior Warden for about thirty-five years.

He was prominently identified with the organization of the Engineers' Society of Western Pennsylvania, was its first President, and, on January 20th, 1880, read the first paper presented to that Society, choosing for his subject "Why Does Steel Harden?"

Mr. Metcalf was elected a Member of the American Society of Civil Engineers on July 2d, 1873. He served as a Director during 1883-1884, and as President in 1893. In the latter year, by virtue of his office as President of the Society, he presided at the meetings of the Engineering Congress held at Chicago during the Columbian Exposition.

He was also a member of the following Societies: American Institute of Mining Engineers, American Society of Mechanical Engineers, American Iron and Steel Association, Institution of Civil Engineers of Great Britain, and the Engineers' Society of Western Pennsylvania.

In his death the Society has lost a valued member, who cherished a deep interest in its welfare, and whose eminent abilities gave force and vigor to those of its discussions in which he participated. He was an earnest and true friend, wise in counsel, charitable in judgment, kindly, with sympathy for all who appealed to him, and universally beloved by all whose privilege it was to know him intimately.

CHARLES MORTON EMMONS, M. Am. Soc. C. E.*

DIED SEPTEMBER 14TH, 1911.

Charles Morton Emmons was born in Hartland, Holland Co., Conn., on January 11th, 1866. With his mother, he moved to Huron, Wayne Co., N. Y., where, later, he lived with Mr. Joseph Chapin and his wife.

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* Memoir prepared by C. H. Vaughan, M. Am. Soc C. E.

At the age of eighteen Mr. Emmons successfully passed the examination for a free scholarship at Cornell University, and was graduated from the Engineering Department in the Class of 1888. Immediately after his graduation, he entered the employ of the Penn Bridge Company, at Beaver Falls, Pa., as Draftsman. He remained with this Company until 1892 when he was appointed Inspector with the United States Engineer Corps, at Buffalo, N. Y., and was employed in supervising the Government work in Buffalo Harbor. In 1897 he was transferred to the U. S. Engineer's Office at Erie, Pa., and, as Junior Engineer, was employed in connection with the Government work in Erie Harbor until 1901. In 1901 Mr. Emmons returned to the Penn Bridge Company as Estimator and Designer, and, later, he was given entire charge of this Department.

On his return to Beaver Falls he took an active interest in the Y. M. C. A., and was President of the Board of Directors for a number of years. He was also active in the Presbyterian Church of Beaver Falls, having been a Trustee for many years; at the time of his death he was an Elder, and also Superintendent of the Sunday-school.

Mr. Emmons' death, which occurred on September 14th, 1911, at the Beaver Valley General Hospital, was caused by an internal cancerous growth. He is survived by his widow, Anna K., and an adopted son, Charles Curtis Emmons. The funeral services were held at the First Presbyterian Church, at Beaver Falls, on September 16th, and the interment was made in Forest Lawn Cemetery, at Buffalo, on September 17th, 1911.

Mr. Emmons was elected a Member of the American Society of Civil Engineers, on April 1st, 1903.

WILLIAM BION EWING, M. Am. Soc. C. E.*

Died April 8th, 1911.

William Bion Ewing was born at Williamsburgh, Pa., on June 21st, 1858. Just prior to the Civil War, his father, William Ewing, with his family, moved to Huntington, Ind., where he was in business as a merchant for more than 40 years. His mother, Anna Ruehl, was a daughter of John Ruehl, of Williamsburgh, Pa., an engineer on the construction of the Brooklyn Bridge under the late John Roebling, M. Am. Soc. C. E. William Bion Ewing was taken to see this bridge when he was quite young, and at once declared his determination to become a Civil Engineer.

During his boyhood he kept this idea before him, and whatever money he could make was saved to help him attain his ambition.

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*Memoir prepared by George H. Bremner, M. Am. Soc. C. E.

Money was not too plentiful in those days, but he persevered year after year, and at last was able to enter Cornell University, from which he was graduated, in 1883, with the degree of Civil Engineer. He worked during his vacations on the Toledo, Delphos, and Burlington Railroad, and practically paid for his own education.

After his graduation Mr. Ewing was employed by the Department of Public Works of New York City on the hydrographic survey of Croton Lake and the location of the Aqueduct.

In 1886 he went to Chicago as Assistant Engineer for the Chicago and Northwestern Railway Company and, for two years, was engaged in locating new lines in Michigan and Minnesota. During this time he also did some bridge work in connection with his surveys.

In 1888 he was employed by the Union Stock Yards Company, Chicago, Ill., and had charge of the construction of various warehouses, viaducts, buildings, pavements, and railroad yards.

In 1889 Mr. Ewing again became Assistant Engineer for the Chicago and Northwestern Railway Company, locating and building tracks and yards in and around Chicago.

From 1890 to 1891 he designed and constructed new water-works at Cazenovia, N. Y., and Litchfield, Conn., the work at Cazenovia including two dams for storage reservoirs. In 1891, he designed the foundation and superintended the erection of two 90-ft. girders, and designed and constructed a filtration well for an additional water supply at Huntington, Ind.

In 1892, he became Chief Engineer of the Chicago Heights Land Association and, until 1895, was employed in designing and laying out the Village of Chicago Heights and in building railroad yards, putting up factories, putting in macadam pavements, and inaugurating a system of water-works at that place. He also designed and superintended the construction of many of its important industrial plants.

From 1895 until his death Mr. Ewing was engaged in general consulting engineering practice in Chicago and its vicinity. He was City Engineer for a number of cities and villages near Chicago, among them being: La Grange, Dalton, Burnham, Duquoin, and Riverdale. During this time he gained many friends and established a wide reputation in the practice of civil, sanitary, and municipal engineering. He designed the water-works systems for Cazenovia, N. Y., Duquoin, Chicago Heights, La Grange Park, Melrose Park, and Summit, Ill. He also designed sewerage systems for La Grange, La Grange Park, Chicago Heights, Wheaton, Geneseo, Dixon, Barrington, Palatine, Arlington Heights, Dalton, Riverdale, Burnham, West Hammond, and Lyons, Ill., and Greensburg, Ind. At the time of his death he was building a large outlet sewer for La Grange, Ill. In addition to these important works, Mr. Ewing had charge of the installation of underground pneumatic tubes for the *Chicago American* and the *Chicago Tribune,* in Chicago.

In 1900 he assisted Desmond FitzGerald, Past-President, Am. Soc. C. E., in his investigation and report on the Chicago Drainage Canal, and measured and made soundings over the entire length of the Chicago River and the Drainage Canal from Lake Street, Chicago, to the dam at Lockport, Ill. During the same year, he also made measurements of all the railroads in the State of Michigan. In 1898 and 1902 he was engaged on preliminary surveys for the Monon Railroad.

On April 5th, 1893, Mr. Ewing was married to Mary E. Crandal, daughter of Edward M. Crandal, of Stevensville, Pa., who, with one daughter, survives him.

His death occurred from heart failure, while on a train on his way to inspect a sewage disposal works which he was constructing at La Grange. This was the first plant of the sprinkling filter type in Illinois.

Mr. Ewing possessed a genial, kindly nature, readily making acquaintances, and these his ability and integrity soon transformed into friends. Wherever he went he brought sunshine and good nature. He lived an upright, honorable, kindly life; his monument is in his work, but his memory will long survive in the hearts of his friends.

He was elected a member of the Western Society of Civil Engineers in 1891. He was also a member of the La Grange Suburban Club, La Grange Lodge No. 777, A. F. and A. M., and the Palisades Park Association, of Covert, Mich.

Mr. Ewing was elected a Junior of the American Society of Civil Engineers on April 3d, 1889, an Associate Member on February 3d, 1892, and a Member on November 2d, 1898.

HORACE JOSEPH HOWE, M. Am. Soc. C. E.*

Died January 21st, 1911.

Horace Joseph Howe was born at Lynn, Mass., on January 2d, 1860. He was graduated from the Medford High School in 1875, after which he entered the Massachusetts Institute of Technology, graduating in 1879, with the degree of S. B. Immediately after his graduation he entered the service of the New York, Lake Erie, and Western Railroad, serving as Rodman, Inspector, and Draftsman. He remained with this company until July, 1881, when he went West and secured employment in the Construction Department of the Northern Pacific

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* Memoir prepared by Theodore Belzner, Assoc. Am. Soc. C. E.

Railroad on the design of wooden bridges, shops, stations, etc., in Minnesota. In 1882, he was appointed Bridge Engineer on the Missoula Division, with headquarters at Missoula, Mont.

In July, 1885, when this work was completed, Mr. Howe came East and, until April, 1886, was employed as Inspector of Bridge Materials on the St. Louis and San Francisco Railway, under the late James Dun, M. Am. Soc. C. E., Chief Engineer. He was also engaged on bridge work under the late George S. Morison, Past-President, Am. Soc. C. E.

In April, 1886, Mr. Howe re-entered the service of the New York, Lake Erie, and Western Railroad, and was employed, until April, 1894, in the Maintenance of Way Department, mostly on the Delaware and Susquehanna Divisions, and also as Roadmaster on about 200 miles of the New York, Pennsylvania, and Ohio Railroad, a leased line.

In September, 1894, he was appointed an Assistant Engineer with the Boston Transit Commission, on preliminary surveys, testing, estimating, designing, etc. He remained with the Commission until 1897, when the work on the Subway was completed. He was then appointed Assistant Engineer on construction work at Forest Hills, for the New York, New Haven, and Hartford Railroad. He was also engaged for a time as Assistant Engineer on the New York Central and Hudson River Railroad.

In 1900 Mr. Howe became an Assistant Engineer for the Rapid Transit Railroad Commission, and, later, for the Public Service Commission, of New York City, which position he held at the time of his death, his work in connection with the construction of the New York Subway, namely, the Manhattan Valley Viaduct, the West Side Viaduct and Extension, the Van Cortlandt Park Extension, and in the moving of the old and the replacing of the new Harlem Ship Canal Bridges, showing his ability in his profession. He presented a paper on the latter subject entitled "Notes on the Replacing of the Superstructure of the Harlem Ship Canal Bridge,"* before the Society on January 5th, 1910. Another valuable paper, entitled "Some Instances of Piles and Pile-Driving, New and Old,"† by Mr. Howe, was presented before the Boston Society of Civil Engineers on March 30th, 1898. He was also an occasional contributor to the professional discussions of this Society, as well as to those of other engineering societies.

Mr. Howe was a gentleman of kindly disposition and remarkably even temperament. He was loyal to his friends and kind and considerate to his subordinates. His ability as an engineer and his value as a citizen, were recognized by all his associates.

He was a Member of the Boston Society of Civil Engineers, the

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* *Transactions*, Am. Soc. C. E., Vol. LXVII, p. 1.

† *Journal*, Assoc. of Eng. Societies. Vol. XX, p. 257.

Municipal Engineers of the City of New York, the National Civil Service Reform Association, and the Technology Club of New York. He was actively interested in church work, and was Treasurer of the Unitarian Club of Yonkers. He was also a member of the Yonkers Choral Union, having served as an officer for many years.

In 1899, Mr. Howe was married to Miss Stella S. Weston, of Medford, Mass., who, with three sons and a daughter, survives him.

Mr. Howe was elected a Junior of the American Society of Civil Engineers on May 2d, 1888, and a Member on March 2d, 1898.

EDWARD MARION KENLY, M. Am. Soc. C. E.*

Died June 10th, 1911.

Edward Marion Kenly was born on June 15th, 1867, at Ritchie Mines, W. Va., where his father, Major Kenly, was Superintendent and Chief Engineer, and, later, Chief Engineer, for many years, of the Baltimore City Water-Works. Mr. Kenly was educated at the Waverly High School, of Baltimore, and at Baltimore College.

He began his professional career in 1885 as Rodman for the Baltimore City Water-Works. In September, 1887, he was appointed Resident Engineer on the Lynchburg and Durham Railroad, which position he held until August, 1888, when he returned to the Baltimore City Water-Works as Assistant Engineer.

In March, 1889, Mr. Kenly went West to the State of Washington and engaged in private practice. He was also Townsite and Topographical Engineer for the Gray's Harbor Land Company.

In the spring of 1891, Mr. Kenly returned to Baltimore, where he was employed as Assistant Engineer, in the City Commissioner's office, in charge of the construction of the Read and Eden Streets sewers. In March, 1892, he was appointed Assistant Supervisor of the grading and masonry for a second track, on the Norfolk and Western Railroad. He remained in this position until June, 1893, when he engaged in private practice in the vicinity of Baltimore.

In the spring of 1894, Mr. Kenly again entered the employ of the Baltimore City Water-Works, as Instrumentman, which position he held until September of the same year, when he was appointed Engineer in charge of surveys and construction on the Baltimore, Middle River, and Sparrow's Point Electric Railroad.

In October, 1895, he was appointed Engineer in charge of improvements at Bay View Asylum, Baltimore, where he designed and built a garbage crematory, an ice manufacturing plant, and a sewerage system. From June, 1896, to February, 1898, Mr. Kenly was engaged in building water-works systems at Handover, New Oxford, and Littlestown, Pa., and at Toneytown, Md.

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* Memoir prepared by N. A. Gilman, Master Mechanic, Yakima Valley Transportation Company, North Yakima, Wash.

In February, 1898, he went to Alaska and engaged in private practice, in the vicinity of Dawson and Forty-Mile, until November of the same year.

In August, 1899, Mr. Kenly became Resident Engineer on the Clearwater Short-Line Railway, in Idaho, and between that time and May, 1900, he also built a water-works system at Crisfield, Md.

In May, 1900, he went to West Virginia as Engineer and Superintendent of the mines controlled by William H. Gorman, of Baltimore, remaining in this position until June, 1905, when he returned to the West as Superintendent of the Montana Coal and Coke Company's mines, at Electric, Mont. He left this position in October, 1906, and went to Seattle, Wash., where between that time and the latter part of December of the same year, he was engaged in confidential work for the Harriman Lines in Western Washington.

In December, 1906, Mr. Kenly removed to North Yakima, Wash., and was employed as Chief Engineer of a proposed electric railroad which, later, he developed into the Yakima Valley Transportation Line. Here he remained as Chief Engineer and Superintendent until his death on June 10th, 1911. In swinging off a street car, Mr. Kenly ruptured the mesentery, and, although an operation was performed in an effort to save his life, it was of no avail. He is survived by his widow, his seventeen-year old daughter, and his one-year old son.

Mr. Kenly had the faculty of gaining the good will and confidence of all with whom he was associated, and was liked by every one. He was devoted to his family and his profession.

Mr. Kenly was elected a Member of the American Society of Civil Engineers on May 4th, 1904.

ALFRED COURTNEY LEWERENZ, M. Am. Soc. C. E.*

DIED MAY 27TH, 1911.

Alfred Courtney Lewerenz was born in Detroit, Mich., on September 24th, 1870. In his early youth he received instruction under Professor Hailleman, one of the earliest exponents in the United States of Froebel's ideas, and now a well-known author and educator. After some further preparatory work in the public schools of Detroit, Mr. Lewerenz entered the University of Michigan from which he was graduated with the degree of Bachelor of Arts, in 1891, and Bachelor of Science in Civil Engineering, in 1892, completing both courses in a total of four years, with an exceptionally brilliant record.

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* Memoir prepared by Leonard M. Cox, M. Am. Soc. C. E.

His first engineering experience was in the capacity of Draftsman with the Detroit Bridge Works, in 1892. Later in the same year he accepted a position as Chief Draftsman with the Chicago, West Michigan, and Detroit, and Lansing and Northern Railroads. In January, 1894, he became Draftsman and Assistant Civil Engineer with the Buffalo, Rochester, and Pittsburgh Railroad, being engaged on surveys, plans, and estimates for extension of line, improvement of grades and alignment, and plans for car shops, depots, and coal-handling apparatus.

In October, 1898, Mr. Lewerenz entered the Government service as Draftsman, under the Bureau of Yards and Docks, Navy Department, Washington, D. C., and was engaged on the designs of the new masonry dry docks at the Boston and the Mare Island Yards, and on various projects involving steel piers, wharves, and other water-front improvements. In March, 1899, he won a commission in the Corps of Civil Engineers of the Navy, with the rank of Lieutenant, Junior Grade, after passing, with a high mark, one of the most severe technical examinations then known.

Mr. Lewerenz's first duty after entering the Navy was as Assistant to the late Peter C. Asserson, M. Am. Soc. C. E., then Civil Engineer, U. S. N., at the New York Navy Yard. He was given entire charge of the construction of brick and steel storehouses, concrete quay walls, yard railways, and designs for new buildings. His tour of duty in the capacity of Assistant was unusually short, owing to the degree of ability he so early displayed and to the small number of officers then available. In June, 1899, he was ordered as Officer in Charge of the Naval Station, at New London, Conn. This detail was a very responsible one for a young officer, and there is no question but that he was selected for this position by M. T. Endicott, President, Am. Soc. C. E., at that time Chief of the Bureau of Yards and Docks, U. S. N., because of the ability he had shown during his service in Washington as a Civilian Assistant. While at New London, Mr. Lewerenz had entire charge of the construction of the coal storage and handling plant at that station, a very considerable amount of dredging work, and a new wharf project.

In February, 1903, he was ordered as Senior Civil Engineer in charge of all engineering work at the Navy Yard, Puget Sound, Wash., one of the most important of our larger naval stations. He was responsible for expenditures on public works amounting to about $500 000 a year, and for the design of many works of improvement, including a coaling plant, wharves, dredging, fire-proof shop buildings, storehouses, water-works, sewers, and electric equipment.

Mr. Lewerenz continued on duty at Puget Sound until November, 1907, when he was ordered to the Navy Yard, at Mare Island, Cal. Here he successfully completed the dry dock and was in charge of all civil engineering work during one of the busiest periods of the upbuilding of this yard. In July, 1910, he was sent to the Hawaiian Islands to take charge of the largest work of navy-yard construction under the Bureau, the building of the new naval base at Pearl Harbor. This work involved the layout and design of a complete naval station, including dredging to cost approximately $3 500 000, a dry dock costing more than $2 500 000, buildings and warehouses, streets, water-front improvements, water-works, sewers, and many other classes of construction. He was engaged on this duty and was carrying it on with his usual expeditious methods and excellent judgment at the time of his death.

Mr. Lewerenz was promoted to the rank of Lieutenant in April, 1906, and in October, 1909, attained the rank of Lieutenant Commander. In the course of his duty on the Hawaiian station, he contracted the malady which ultimately caused his death. For some months he made every effort to overcome the trouble, with the hope of continuing on duty, but his condition did not improve, and in the spring of 1911, he was ordered to the Mare Island Hospital, and there placed on the retired list. He died on May 27th, 1911, at the residence of relatives, in Detroit.

In the death of Mr. Lewerenz, the United States Navy, and especially the Corps of Civil Engineers, loses a most valuable officer. The splendid work that he accomplished at every station to which he was detailed, was acknowledged by all his brother officers, as well as by those members of the civil engineering profession at large who were familiar with it. His record was an enviable one, and gave promise of an exceptionally bright and useful future. He was a man of excellent judgment, sound professional knowledge, and great executive ability.

By nature, Mr. Lewerenz was gentle and lovable, gaining his triumphs in great part by the unconscious influence he exerted over all with whom he came in contact. He was highly esteemed by his superior officers, and popular with those under his direction. Among the officers of his own corps, his loss is mourned as that of a brother and friend. His unfailing cheery disposition, his unselfishness, his great strength of character, and his ready sympathy, as well as his fine and wholesome personality, are traits which will long be remembered.

Mr. Lewerenz was married on October 21st, 1906, to Miss Harriet Elizabeth Speir of Albany, N. Y., who, with their one son, Alfred C. Lewerenz, Jr., survives him. Their home life was delightful, and those who were fortunate enough to enjoy their hospitality were impressed by the love and Christian character that pervaded it.

Mr. Lewerenz was elected a Junior of the American Society of Civil Engineers on March 5th, 1895, an Associate Member on June 6th, 1900, and a Member on March 6th, 1906.

JAMES SMITH, M. Am. Soc. C. E.*

Died February 20th, 1911.

James Smith was born at Row, Dumbartonshire, Scotland, on September 9th, 1872. From 1887 to 1891 he was an articled pupil and assistant to Daniel Macalister, M. Inst. C. E., at Greenock, Scotland, and was engaged principally on designs and estimates for dock and harbor works. In 1892 he entered the employ of Messrs. P. and W. MacLellan, Ltd., Engineers and Contractors, and remained with this firm until his death.

From January to August, 1892, Mr. Smith was Resident Engineer on the removal and reconstruction of Bilston Viaduct, on the North British Railway. The old viaduct was taken down and removed, new masonry piers, abutments, and approaches were built, and more than 700 tons of steelwork were erected, without interfering with through railway traffic. From August, 1892, until May, 1896, he was engaged in designing and estimating on general engineering work, and had practical experience in the steel car and bridge building workshops of the Clutha Works of Glasgow.

From May, 1896, to May, 1901, he was Resident Engineer at the Waverley Station, North British Railway, Edinburgh, supervising the contract work for Messrs. P. and W. MacLellan, Ltd., which included the removal of footbridges, approaches, and roofing of the station, and the reconstruction of the entire system, together with new foundations and a new system of drainage. The whole of this work, covering an area of about 12 acres, was done without interfering with existing railway or street traffic.

From May to October, 1901, Mr. Smith was engaged in designing and estimating on a number of engineering projects, among which were two swing bridges for Egypt, granaries and elevator towers for Buenos Aires, station extension for the Caledonian Railway at Glasgow, and widening at College, Glasgow, for the North British Railway. In October, 1901, he was sent to Mexico to report on the erection of a system of steel wharves for the Port of Coatzacoalcos (Puerto Mexico). In December of that year he returned to Glasgow, and was there engaged for the next six months in inspecting work for the Iquitos jetty on the

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*Memoir prepared by the Secretary from information furnished by Sidney Smith, Esq., and from papers on file at the House of the Society.

River Amazon, and also on the preliminary work for the Coatzacoalcos wharves.

In December, 1901, Mr. Smith was married to Miss Anne Lawson Turnbull, eldest daughter of Mr. George Turnbull, Headmaster of the Bewick Schools, Howden, Newcastle-on-Tyne. There were no children.

In July, 1902, he was appointed Manager and Chief Engineer on the construction of steel wharves and warehouses at Coatzacoalcos, and warehouses at Salina Cruz, for Messrs P. and W. MacLellan, Ltd., as contractors for Messrs. S. Pearson and Son, Ltd., in connection with the latter firm's agreement with the Mexican Government. These works comprise 4 630 ft. frontage of steel wharves and six double warehouses, each 416 ft. by 106 ft., at Coatzacoalcos, and three double warehouses of the same size at Salina Cruz.

Mr. Smith remained in Mexico until late in 1908 and then returned to Scotland. In August, 1909, he was sent to India, by his firm, as Resident Engineer on the construction of the Manharpur Light Railway for the Bengal Iron and Steel Company. This railway from Manharpur to Notu, passes through thick jungle, in very heavy, hilly country, and had to be built during the dry season. While prosecuting this work, Mr. Smith was attacked repeatedly by jungle fever, and, though his firm advised him to take matters easier, he persisted in his endeavor to complete the road within the specified time. Finally, in December, 1910, his medical advisers ordered him home if he wished to save his life. He arrived in London on January 1st, 1911, though, during the voyage, both he and his wife were seriously ill. They went to St. Margaret's-on-Thames, but, by this time, malaria had weakened Mr. Smith's constitution so much that he contracted acute tuberculosis of the lungs, and died on February 20th. He was buried in Cathcart Cemetery, Glasgow, his funeral being attended by two of the Directors of Messrs. P. and W. MacLellan, Ltd., by which firm he was held in the highest esteem. Mr. William Turner MacLellan, Chairman of the Board, to whom he owed all his training as an engineer, was one of his stanchest friends. The Directors of the Bengal Iron and Steel Company sent a beautiful wreath bearing the inscription: "An able and devoted servant who placed duty before personal consideration." A more fitting epitaph could not have been written of him.

Mr. Smith was gentle, kind, and generous, but, nevertheless had an inflexible will, and there is no doubt that over-zeal in the interest of his employers hastened his death, which ended a career full of bright prospects.

An illuminated address, from the members of his staff in India, engrossed on silk and enclosed in a silver casket, was received on February 22d, just two days too late for him to see.

James Smith was elected an Associate Member of the American Society of Civil Engineers on November 1st, 1905, and a Member on March 31st, 1908.

WILLIAM DANA TAYLOR, M. Am. Soc. C. E.*

Died August 26th, 1911.

William Dana Taylor, the son of William Thomas and Mary (Hubbard) Taylor, was born in Montgomery, Ala., on January 22d, 1859. He was graduated from the Alabama Polytechnic Institute in 1881, with the degree of B. E., and in 1885 received the degree of C. E. He also did post-graduate work at Johns Hopkins, Cornell, and Chicago Universities.

During his professional life, extending over thirty years, he held many positions of great trust, and in none did he fail to give satisfaction.

From 1882 until 1886, Mr. Taylor was employed on surveys for the Mexican Central, in Mexico, and as a teacher in public schools in Alabama. In 1886, he was appointed Resident Engineer on the construction of a portion of the Birmingham Mineral Railroad, an important and extensive subsidiary of the Louisville and Nashville Railroad in the mineral district of Alabama. His ability soon caused his appointment as Chief Engineer of Construction of all the Louisville and Nashville lines then building in Alabama, which position he retained until the completion of the construction in 1891. He quickly acquired a reputation as an engineer who succeeded in getting work completed within the contract time.

From 1891 to 1898, the long period during which railway construction in the South was at a standstill, Mr. Taylor filled the Chair of Civil Engineering at the Louisiana State University. Resigning that position in 1898, he re-entered the more active engineering life as Chief Engineer of the St. Louis, Peoria, and Northern Railroad, which was planned as a new competitor for St. Louis and Chicago traffic. Shortly after the surveys for this line had been completed and the construction begun, its purchase by the Chicago and Alton Railroad Company caused its abandonment and the transfer of Mr. Taylor to the Engineering Department of the Alton, as Assistant Engineer. His most important work in this position was the reconstruction of the Missouri River Bridge, at Glasgow, Mo., and the surveys for track elevation in Chicago.

In 1901, Mr. Taylor resigned his position to become Professor of Railway Engineering at the University of Wisconsin, where he remained until February 1st, 1906, when he was appointed Chief Engineer of the Chicago and Alton Railroad. When the control of the Alton passed to the Toledo, St. Louis and Western Railroad, Mr. Taylor was the only general officer (with one exception) who was retained by the new management. Later in 1907, he became Chief Engineer of the Toledo, St. Louis and Western Railroad, and, in 1909,

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* Memoir prepared by J. E. Willoughby, M. Am. Soc. C. E.

Chief Engineer of the allied lines, the Minneapolis and St. Louis and the Iowa Central. At the time of his death he was Chief Engineer of the Chicago and Alton and of the Toledo, St. Louis, and Western.

In addition to these positions, and sometimes in connection with them, Mr. Taylor held other important assignments. He was Captain of the Third United States Volunteer Engineer Corps during the Spanish-American War in 1898. In 1901, he made an appraisal of the physical properties of some of the Lake Superior ore-carrying roads for the Minnesota Railroad and Warehouse Commission; and, in 1902, obtaining leave of absence from the University of Wisconsin, he, as Chief Engineer, located the Knoxville, La Follette and Jellico Railroad (a subsidiary line of the Louisville and Nashville), from Jellico, Tenn., through eighty miles of difficult country, to Knoxville, Tenn. A paper entitled, "The Location of the Knoxville, La Follette, and Jellico Railroad, of the Louisville and Nashville System,"* containing a complete description of this work, was presented by Mr. Taylor before the Society on March 16th, 1904.

From 1903 to 1906, he acted as Expert Engineer for the State Board of Assessors of Wisconsin, and directed the re-valuation of the railways of that State—a notable achievement. He also made reconnaissances in the Continental Divide, was in demand as an expert witness in lawsuits involving the determination of engineering questions, and performed various other professional work.

Mr. Taylor was a frequent contributor to the engineering press, and to the publications of the various societies of which he was a member. His papers were exact and forcible, and gave evidence of vigorous thought. In the classroom, and in his more active life, his teaching was clear and was given with such kindness that he built up for himself, among the student body at his universities and among the young men in his employ, lasting friendships which added much to his pleasure and to the comfort and advancement of those who were associated with him. One of his former students writes:

> "The grateful memory of his personality cheered and steadied me, and I have often said that W. D. Taylor was the most utterly unselfish man that I had ever met."

Imbued with the puritanism of the Presbyterian Church, of which he was a member, Mr. Taylor lived after its standards. In 1884, he was married to Miss Mary Ross, of Auburn, Ala. His second wife was Miss Annie L. MacIntyre, of Le Grand, Ala. Three children were born of each marriage.

Mr. Taylor was elected a Member of the American Society of Civil Engineers on March 1st, 1899. He was also a Member of the American Railway Engineering and Maintenance of Way Association, the Western Society of Engineers, the Society for the Promotion of Engineering Education, and of the Chicago Engineers' Club.

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* *Transactions*, Am. Soc. C. E., Vol. LII, p. 467.

EARL EDWIN ERDMANN, Jun. Am. Soc. C. E.*

DIED MARCH 28TH, 1910.

Earl Edwin Erdmann was born at Big Suamico, Wis., on June 15th, 1883. His early education was received at the local schools and at the West Green Bay High School. In 1903 he entered the University of Wisconsin, where he remained for two years. In 1905 he entered the University of Washington, at Seattle, Wash., receiving the degree of B. S. in Civil Engineering from that institution in June, 1907.

Mr. Erdmann began his engineering work in the summer of 1905 on maintenance of way on the Chicago Division of the "Big Four" Railway. In the summer of 1906 he was employed as Instrumentman by the Seattle Electric Company, and as Draftsman and Topographer on location for the Oregon and Washington Railroad Company.

After his graduation in 1907, he was employed as Instrumentman in building the substructure of the Columbia River Bridge for the Chicago, Milwaukee and St. Paul Railway Company, of Washington, until September, 1908, when he was appointed Resident Engineer in charge of the construction of the falsework for the steel erection and trestle approaches for the same bridge, and also of the engineering work required in connection with the erection of the steel superstructure.

On the completion of the work on the Columbia River Bridge, Mr. Erdmann was appointed Inspector of Bridges for the Chicago, Milwaukee and Puget Sound Railway Company, covering the territory from Butte, Mont., to Seattle and Tacoma, Wash., which position he held until his final illness.

In 1905, Mr. Erdmann was married to Miss Iva L. Hill, who, with a son, survives him.

Mr. Erdmann was a man of great determination, a faithful worker, and gave promise of becoming an able engineer.

He was elected a Junior of the American Society of Civil Engineers on July 17th, 1909.

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* Memoir prepared by R. H. Ober, M. Am. Soc. C. E.

William P. Morse

PROCEEDINGS

OF THE

AMERICAN SOCIETY

OF

CIVIL ENGINEERS

VOL. XXXVII—No. 10

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By
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OF

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(INSTITUTED 1852)

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◆

The House of the Society is open from 9 a. m. to 10 p. m. every day, except Sundays, Fourth of July, Thanksgiving Day, and Christmas Day.

House of the Society—220 West Fifty-seventh Street, New York.

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Cable Address..................."Ceas, New York."

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AMERICAN SOCIETY OF CIVIL ENGINEERS

INSTITUTED 1852

PROCEEDINGS

This Society is not responsible for any statement made or opinion expressed in its publications.

SOCIETY AFFAIRS

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MINUTES OF MEETINGS

OF THE SOCIETY

November 15th, 1911.—The meeting was called to order at 8.30 P. M.; Director W. E. Belknap in the chair; Chas. Warren Hunt, Secretary; and present, also, 114 members and 25 guests.

A paper by J. M. O'Hara, Assoc. M. Am. Soc. C. E., entitled "Retrogression in the Tensile Strength of Cement," was presented by the Secretary, who also read communications on the subject from Messrs. Maurice G. Parsons and Clifford Richardson. The paper was discussed orally by Messrs. T. Kennard Thomson, E. P. Goodrich, E. D. Knap, and R. S. Greenman.

The Secretary also presented a paper by W. W. Clifford, Jun. Am. Soc. C. E., entitled "A Reinforced Concrete Stand-Pipe," and read communications on the subject from Messrs. William Fry Scott and William Mueser. The paper was discussed orally by Joseph A. Powers, M. Am. Soc. C. E.

The Secretary presented a communication from the National Waterways Commission, inviting the members of the Society to take part in the discussion at the hearings on the question of water power, to be held in Washington, D. C., beginning November 21st, 1911.

The Secretary announced the death of:

Basil Henry Leather, elected Associate June 1st, 1904; died October 31st, 1911.

Adjourned.

December 6th, 1911.—The meeting was called to order at 8.30 p. m.; Foster Crowell, M. Am. Soc. C. E., in the chair; Chas. Warren Hunt, Secretary; and present, also, 126 members and 9 guests.

The minutes of the meetings of October 18th and November 1st, 1911, were approved as printed in *Proceedings* for November, 1911.

A paper by E. A. Moritz, Assoc. M. Am. Soc. C. E., entitled "Experiments on the Flow of Water in Wood Stave Pipes," was presented by the Secretary, who also read communications on the subject by Messrs. Robert G. Dieck, J. L. Campbell, Melvin L. Enger, Rudolph Hering, and J. S. Moore.

The Secretary also presented a paper by C. A. P. Turner, M. Am. Soc. C. E., entitled "The St. Croix River Bridge," and read a communication on the subject by C. M. Spofford, M. Am. Soc. C. E.

The Secretary announced the election of the following candidates on December 5th, 1911:

As Members.

Harry Edward Eckles, Kansas City, Mo.
Ferris LeRoy Francisco, Jersey City, N. J.
Charles Allyn Gilchrist, Manila, Philippine Islands.
Ralph Stevenson Hawley, Berkeley, Cal.
Milton Jacob Henoch, Sioux City, Iowa.
John Irvin Horrocks, Seattle, Wash.
Wilson Tyler Howe, Manila, Philippine Islands.
John Leitch, Bankipore, Bengal, India.
Laurence Francis McCoy, Spokane, Wash.
Charles Joseph McDonough, Buffalo, N. Y.
Shirley Seavey Philbrick, Clarkston, Wash.
Dunbar Doolittle Scott, Rochester, N. Y.
Louis Edward Strothman, Milwaukee, Wis.
Samuel Matthews Vauclain, Philadelphia, Pa.

As Associate Members.

James Wilbur Beebe, Prescott, Ark.
Clarence Moore Blair, New Haven, Conn.

William Tucker Colman, Chicago, Ill.
George Wells Ely, Jr., New York City.
William James Fairbairn, Detroit, Mich.
Donald Young Geddes, Zanesville, Ohio.
Jesse K Giesey, Marquette, Mich.
Edward Lee Harrison, Memphis, Tenn.
Alfred Levy, Puerto Plata, Santo Domingo.
Samuel Bicknell Lincoln, Boston, Mass.
Andrew Jackson McKenzie, Webb City, Mo.
William Duncan Malcolm, Newark, N. J.
Edward Thomas Every Miller, Cordoba, Argentine Republic.
Elbert James Nelson, Greenville, Miss.
James Athersmith Orrell, Bradford, England.
Frank Alfred Randall, Chicago, Ill.
Arthur Pierce Robinson, Indianapolis, Ind.
William Day Shannon, Sumner, Wash.
Claiborne Ellis Smith, La Mesa, Cal.
George Hippesley Stanley Stephens, Caledon, Cape Colony, South Africa.
Benjamin Franklin Stewart, Jr., Parkersburg, W. Va.
Edward Calderwood Thomes, Poplar Bluff, Mo.
Lockwood Janes Towne, Chicago, Ill.
Albert Alexander Van Petten, Anasco, Porto Rico.
Norton Ware, San Francisco, Cal.

As Associate.

Jonathan Rhodes Smith, New York City.

As Juniors.

Arthur Carl Alvarez, Berkeley, Cal.
Harold Law Blakeslee, Kitchawan, N. Y.
Massena Laron Culley, Jackson, Miss.
Lloyd Harrison Faidley, St. Louis, Mo.
Willis George Frost, Redwood City, Cal.
Nathaniel Warren Green, Helena, Ark.
Lester Gurney, Bourne, Mass.
Kikumatsu Hirai, Asahigawa, Hokkaido, Japan.
William Hunter McDowell, Narberth, Pa.
Claire Howland Wallace Smith, Blanca, Colo.
Robert Hall Smith, Jr., Bandy, Va.
George Robert Strandberg, Seattle, Wash.
Walter Gottfrid Stromquist, Urbana, Ill.
Carl August Wigholm, Oakland, Cal.
Claude Thomas Wilson, Bath Beach, N. Y.

The Secretary announced the transfer of the following candidates on December 5th, 1911:

From Associate Member to Member.

Charles Houchin Higgins, Jersey City, N. J.
Emile George Perrot, Philadelphia, Pa.
Sam Graham Porter, Holly, Colo.
Phillip Jacob Reich, Toledo, Ohio.
Edwin Howard Thomes, Jamaica, N. Y.

From Junior to Associate Member.

Alexander William Dann, Benoit, Miss.
Everett Hamilton Hatch, Rancagua, Chili.
Leroy Littlefield Hunter, Chicago, Ill.
James Francis Loughran, New Rochelle, N. Y.
Henry Lanark Miller, Mendoza, Argentine Republic.
Warren Crosby Taylor, Schenectady, N. Y.
Harry Chittenden Vensano, San Francisco, Cal.
Adalbert George Volck, New York City.

The Secretary announced the following deaths:

Benjamin Douglas, elected Junior, June 1st, 1887; Member, January 2d, 1890; died November 13th, 1911.

Joseph James Ferrier, elected Junior, December 3d, 1907; died October 30th, 1911.

Adjourned.

December 20th, 1911.—Because of the necessity of going to press with this number of *Proceedings* in advance of this meeting, the publication of its minutes must be deferred until January, 1912. Three papers have been set down for discussion: "Construction of the Morena Rock Fill Dam, San Diego County, California," by M. M. O'Shaughnessy, M. Am. Soc. C. E.; "The Halligan Dam: A Reinforced Masonry Structure," by G. N. Houston, M. Am. Soc. C. E.; and "Provision for Uplift and Ice Pressure in Designing Masonry Dams," by C. L. Harrison, M. Am. Soc. C. E.

OF THE BOARD OF DIRECTION

(Abstract)

December 5th, 1911.—Vice-President Boller in the chair; Chas. Warren Hunt, Secretary; and present, also, Messrs. Belknap, Clarke, Kimball, Knap, Loomis, Ridgway, Roberts, Snow, Stearns, Talbot, and Thompson.

The participation of this Society in the Panama-Pacific Exposition, to be held in San Francisco in 1915, was considered.

George F. Swain, M. Am. Soc. C. E., was appointed to represent this Society at the Sixth Congress of the International Association for Testing Materials.

The Secretary reported that he had received additional nominations, under the Constitution, for offices of the Society as follows:

For the office of President, to serve one year, Richard Montfort, M. Am. Soc. C. E.

For the office of Director, representing District No. 1, to serve three years, George S. Rice, M. Am. Soc. C. E.

President Mordecai T. Endicott was appointed a representative of this Society, to serve four years, on the John Fritz Medal Board of Award.

Upon the request of the Committee to Formulate Principles and Methods for the Valuation of Railroad Property and Other Public Utilities, an appropriation not to exceed $1 500, was made, for the employment of such clerical assistance as the Committee may deem necessary to carry out its work.

The resignations of four Associate Members and five Juniors were accepted.

Ballots for membership were canvassed, resulting in the election of 14 Members, 25 Associate Members, 1 Associate, and 15 Juniors, and the transfer of 8 Juniors to the grade of Associate Member.

Five Associate Members were transferred to the grade of Member.

Applications were considered, and other routine business transacted.

Adjourned.

ANNOUNCEMENTS

The House of the Society is open from 9 A. M. to 10 P. M., every day, except Sundays, Fourth of July, Thanksgiving Day, and Christmas Day.

FUTURE MEETINGS

January 3d, 1912.—8.30 P. M.—A regular business meeting will be held, and a paper by Henry C. Ripley, M. Am. Soc. C. E., entitled "How to Build a Stone Jetty on a Sand Bottom in the Open Sea," will be presented for discussion.

This paper was printed in *Proceedings* for November, 1911.

Wednesday and Thursday, January 17th and 18th, 1912.—The Fifty-ninth Annual Meeting will be held. The Business Meeting will be called to order at 10 o'clock on Wednesday morning at the Society House. The Annual Reports will be presented, officers for the ensuing year elected, members of the Nominating Committee appointed, Reports of Special Committees presented for discussion, and other business transacted.

Arrangements for the Annual Meeting have been placed in the hands of the following committee: Messrs. Arthur S. Tuttle, Austin Lord Bowman, and Charles Warren Hunt.

February 7th, 1912.—8.30 P. M.—At this meeting, a paper by Frederick C. Noble, M. Am. Soc. C. E., entitled "Notes on a Tunnel Survey," will be presented for discussion.

This paper is printed in this number of *Proceedings.*

SPECIAL MEETINGS FOR TOPICAL DISCUSSION

On the two days immediately following the Annual Meeting, three meetings of the Society will be held, at which the subject for discussion will be "Road Construction and Maintenance."

The meetings will be held as follows:

First Meeting, Friday, January 19th, 1912.—10 A. M.—Two subdivisions of the subject will be discussed.

(1) "Drainage and Foundations."

The discussion on this topic will be introduced by James Owen, M. Am. Soc. C. E.

(2) "Fillers for Brick and Block Pavements."

The opening discussion on this topic will be by George W. Tillson, M. Am. Soc. C. E.

Second Meeting, Friday, January 19th.—2 P. M.— The following sub-division of the subject will be discussed:

(3) "Bituminous Surfaces."

This topic will be introduced by A. W. Dean, M. Am. Soc. C. E.

Third Meeting, Saturday, January 20th.—10 A. M.— The following sub-division of the subject will be discussed:

(4) "Use of Bituminous Material in Penetration and Mixing Methods."

The discussion on this topic will be introduced by Linn White, Esq.

All Engineers, whether members of the Society or not, are cordially invited to attend these meetings, and it is hoped that the resulting discussion, when collated and published, will bring the whole subject up to date.

CHANGES IN METHOD OF PUBLISHING TRANSACTIONS

The *Transactions*, which during the past three years have been issued in four volumes per year, will in 1912 and thereafter be published in one annual volume.

This important change has been decided on by the Board of Direction because it will overcome, or mitigate to a considerable extent, the many disadvantages connected with the old system, as detailed in the report of the Secretary to the Board dated June 6th, 1911 (*Proceedings* for August, 1911, p. 319).

The yearly volumes will be printed on thin "India" or "Bible" paper, and will contain approximately as much material as four of the volumes hitherto published. Its thickness will be somewhat less than half that of the four volumes combined.

To non-members the subscription for this single volume, if entered before February 1st, will be the same as heretofore for the four volumes: $12, with a discount to libraries, book dealers, etc., of 25 per cent.

To members the cost of binding will be $1.50 per volume for half morocco and 75 cents for cloth, thus effecting a saving of from $1.25 to $2.50 per annum to each member who has his *Transactions* bound.

It is expected that the volume for 1912 (Vol. LXXV) will be issued toward the close of the year.

SEARCHES IN THE LIBRARY

In January, 1902, the Secretary was authorized to make searches in the Library, upon request, and to charge therefor the actual cost to the Society for the extra work required. Since that time many searches have been made, and bibliographies and other information on special subjects furnished.

The resulting satisfaction, to the members, who have made use of the resources of the Society in this manner, has been expressed frequently, and leaves little doubt that, if it were generally known to the membership that such work would be undertaken, many would avail themselves of it.

The cost is trifling compared with the value of the time of an engineer who looks up such matters himself, and the work can be performed quite as well, and much more quickly, by persons familiar with the Library.

In asking that such work be undertaken, members should specify clearly the subject to be covered, and whether references to general books only are desired, or whether a complete bibliography, involving search through periodical literature, is desired.

In reference to this work, the Appendices* to the Annual Reports of the Board of Direction for the years ending December 31st, 1906, and December 31st, 1910, contain summaries of all searches made to date.

PAPERS AND DISCUSSIONS

Members and others who take part in the oral discussions of the papers presented are urged to revise their remarks promptly. Written communications from those who cannot attend the meetings should be sent in at the earliest possible date after the issue of a paper in *Proceedings.*

All papers accepted by the Publication Committee are classified by the Committee with respect to their availability for discussion at meetings.

Papers which, from their general nature, appear to be of a character suitable for oral discussion, will be published as heretofore in *Proceedings,* and set down for presentation to a future meeting of the Society, and, on these, oral discussions, as well as written communications, will be solicited.

All papers which do not come under this heading, that is to say, those which, from their mathematical or technical nature, in the opinion of the Committee, are not adapted to oral discussion, will not be scheduled for presentation to any meeting. Such papers will be published in *Proceedings* in the same manner as those which are to be presented at meetings, but written discussions, only, will be requested for subsequent publication in *Proceedings* and with the paper in the volumes of *Transactions.*

LOCAL ASSOCIATIONS OF MEMBERS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS

San Francisco Association

The San Francisco Association of Members of the American Society of Civil Engineers holds regular bi-monthly meetings, with banquet, and weekly informal luncheons. The former are held at 6 P. M., at the Palace Hotel, on the third Friday of February, April, June, August,

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*Proceedings, Vol. XXXIII, p. 20 (January, 1907); Vol. XXXVII, p. 28 (January, 1911).

October, and December, the last being the Annual Meeting of the Association.

Informal luncheons are held at 12.15 P. M. every Wednesday, and the place of meeting may be ascertained by communicating with the Secretary of the Association, E. T. Thurston, Jr., M. Am. Soc. C. E., 713 Mechanics' Institute, 57 Post Street.

The by-laws of the Association provide for the extension of hospitality to any member of the Society who may be temporarily in San Francisco, and any such member will be gladly welcomed as a guest.

Colorado Association

The meetings of the Colorado Association of Members of the American Society of Civil Engineers are held on the second Saturday of each month, except July and August. The hour and place of meeting are not fixed, but this information will be furnished on application to the Secretary, Gavin N. Houston, M. Am. Soc. C. E., 409 Equitable Building, Denver, Colo. The meetings are usually preceded by an informal dinner. Members of the American Society of Civil Engineers will be welcomed at these meetings.

Weekly luncheons are held on Wednesdays, and until further notice, will take place at the Colorado Traffic Club.

Visiting members are urged to attend the meetings and luncheons.

PRIVILEGES OF ENGINEERING SOCIETIES EXTENDED TO MEMBERS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS

Members of the American Society of Civil Engineers will be welcomed by the following Engineering Societies, both to the use of their Reading Rooms and at all Meetings:

American Institute of Mining Engineers, 29 West Thirty-ninth Street, New York City.

American Society of Mechanical Engineers, 29 West Thirty-ninth Street, New York City.

Architekten-Verein zu Berlin, Wilhelmstrasse 92, Berlin W. 66, Germany.

Associação dos Engenheiros Civis Portuguezes, Lisbon, Portugal.

Australasian Institute of Mining Engineers, Melbourne, Victoria, Australia.

Boston Society of Civil Engineers, 715 Tremont Temple, Boston, Mass.

Brooklyn Engineers' Club, 117 Remsen Street, Brooklyn, N. Y.

Canadian Society of Civil Engineers, 413 Dorchester Street, West, Montreal, Que., Canada.

Civil Engineers' Society of St. Paul, St. Paul, Minn.

Cleveland Engineering Society, Chamber of Commerce Building, Cleveland, Ohio.

Cleveland Institute of Engineers, Middlesbrough, England.

Dansk Ingeniorforening, Amaliegade 38, Copenhagen, Denmark.

Engineers' and Architects' Club of Louisville, Ky., 303 Norton Building, Fourth and Jefferson Streets, Louisville, Ky.

Engineers' Club of Baltimore, Baltimore, Md.

Engineers' Club of Minneapolis, 17 South Sixth Street, Minneapolis, Minn.

Engineers' Club of Philadelphia, 1317 Spruce Street, Philadelphia, Pa.

Engineers' Club of St. Louis, 3817 Olive Street, St. Louis, Mo.

Engineers' Club of Toronto, 96 King Street, West, Toronto, Ont., Canada.

Engineers' Society of Northeastern Pennsylvania, 302 Board of Trade Building, Scranton, Pa.

Engineers' Society of Pennsylvania, 219 Market Street, Harrisburg, Pa.

Engineers' Society of Western Pennsylvania, 2511 Oliver Building, Pittsburg, Pa.

Institute of Marine Engineers, 58 Romford Road, Stratford, London, E., England.

Institution of Engineers of the River Plate, Buenos Aires, Argentine Republic.

Institution of Naval Architects, 5 Adelphi Terrace, London, W. C., England.

Junior Institution of Engineers, 39 Victoria Street, Westminster, S. W., London, England.

Koninklijk Instituut van Ingenieurs, The Hague, The Netherlands.

Louisiana Engineering Society, 321 Hibernia Bank Building, New Orleans, La.

Memphis Engineering Society, Memphis, Tenn.

Midland Institute of Mining, Civil and Mechanical Engineers, Sheffield, England.

Montana Society of Engineers, Butte, Montana.

North of England Institute of Mining and Mechanical Engineers, Newcastle-upon-Tyne, England.

Oesterreichischer Ingenieur- und Architekten-Verein, Eschenbachgasse 9, Vienna, Austria.

Pacific Northwest Society of Engineers, 803 Central Building, Seattle, Wash.

Rochester Engineering Society, Rochester, N. Y.

Sachsischer Ingenieur- und Architekten-Verein, Dresden, Germany.

Sociedad Colombiana de Ingenieros, Bogota, Colombia.

Sociedad de Ingenieros del Peru, Lima, Peru.

Societe des Ingenieurs Civils de France, 19 Rue Blanche, Paris, France.

Society of Engineers, 17 Victoria Street, Westminster, S. W., London, England.

Svenska Teknologforeningen, Brunkebergstorg 18, Stockholm, Sweden.

Tekniske Forening, Vestre Boulevard 18–1, Copenhagen, Denmark.

Western Society of Engineers, 1737 Monadnock Block, Chicago, Ill.

ACCESSIONS TO THE LIBRARY

(From November 7th to December 8th, 1911)

DONATIONS *

LES OSCILLATIONS DU MATÉRIEL DES CHEMINS DE FER ET LA VOIE.

Par Georges Marié. Paper, 10 x 6½ in., 11 x 7½ in., illus., 2 vol. Paris, H. Dunod et E. Pinat, 1911. Vol. I, 3 francs; Vol. II, 2 francs.

The author's earlier works on this subject were crowned by the Académie des Sciences in 1906 and by the Société des Ingenieurs Civils de France in 1906 and 1910. These two volumes are said to complete the series and, together, to include the values which should be given for the flexibility of springs for various types of cars, in order to minimize the chances of derailment, and also the speed limits to be fixed for cars which are to run on a line having given curves. The Contents are: Vol. I, Denivellations de la Voie et Oscillations des Vehicules de Chemins de Fer; Vol. II, Limites de Flexibilité des Ressorts et Limites de Vitesse du Matériel des Chemins de Fer.

DEFLECTIONS AND STATICALLY INDETERMINATE STRESSES.

By Clarence W. Hudson, M. Am. Soc. C. E. Cloth, 11¼ x 8 in., illus., 13 + 258 pp. New York, John Wiley & Sons; London, Chapman & Hall, Limited, 1911. $3.50. (Donated by the Author and the Publisher.)

This text-book, it is stated, is intended to give the underlying principles of the subject and to show their application to a number of problems to which they apply. In many of the general demonstrations and in the solution of some of the special problems, the principle of the work of deformation has been freely used, it is stated, but the determination of the statically indeterminate stresses and reactions has been generally made directly from the proportionality between load and deformation as the basis. Several methods of determining the deformations which an elastic body undergoes when subjected to load are developed, as are also methods of finding the distortion of elastic structures, and their importance, especially in bridge erection, is shown. The author states that he has given much prominence to the method of finding deflections by means of the work due to an auxiliary load of unity, for both solid and open webbed structures as being the simplest of all methods of computing deflections. Formulas for finding unknown crown forces for both the solid webbed and braced arch are published, it is stated, for the first time, and the comparison of the exact and approximate methods of integration in finding the deflections of certain structures should be of value. The Contents are: Elementary Indeterminate Forms; Deflections and Reactions of Straight Structures with Solid Webs; Deflections and Stresses for Curved Structures with Solid Webs; Arches with Solid Webbed Ribs; Deflections of Structures with Either Solid or Open Webs; Deflections and Stresses in Structures with Open Webs; Movable Bridges; The Arch with an Open Framework Web; Distortions of Structures as Affecting Their Erection; Adjusting Devices and the Necessary Adjustments Required to Make the Final Connections for Important Structures; Miscellaneous Structures and Problems; Index.

THE DESIGN OF WALLS, BINS AND GRAIN ELEVATORS.

By Milo Ketchum, M. Am. Soc. C. E. Second Edition, Revised and Enlarged. Cloth, 9 x 6¼ in., illus., 19 + 556 pp. New York. The Engineering News Publishing Company; London, Archibald Constable & Co., Ltd., 1911. $4.00.

The author's aim in this book, it is stated, has been to present a systematic analysis of the stresses due to granular materials, together with a discussion of the principles of design and the details of structures which contain such materials. The sequence developed by the author in his investigations has been followed, namely, the design of retaining walls, the design of bins for coal, ore, etc., and the design of grain bins and elevators. The subject-matter is said to include discussion of the graphic methods for calculating pressures on retaining walls and in hopper bins; the theory of reinforced concrete and formulas necessary for its use in design; results of experiments on the pressure of granular materials; cost

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* Unless otherwise specified, books in this list have been donated by the publisher.

data; and descriptions of numerous examples of actual structures. In this, the second edition, the author states that more than 150 pages of new matter have been added, together with many new cuts. The chapters on Reinforced Concrete Materials and Methods of Construction and Cost of Retaining Walls have been entirely rewritten. Two new chapters have been added, together with additional examples of retaining walls; formulas and designs for bins; descriptions of reinforced concrete grain bins and elevators; an appendix giving a brief résumé of plain and reinforced concrete, etc. The Contents are: Part I, The Design of Retaining Walls: Rankine's Theory; Rankine's Theory Modified; Coulomb's Theory; Design of Masonry Retaining Walls; Reinforced Concrete Retaining Walls; Effect of Cohesion, Stresses in Bracing of Trenches, Stresses in Tunnels; Experiments on Retaining Walls; Examples of Retaining Walls; Methods of Construction and Cost of Retaining Walls. Part II, The Design of Coal Bins, Ore Bins, Etc.: Types of Coal Bins, Ore Bins, etc.; Stresses in Bins; Experiments on Pressures on Bin Walls; The Design of Bins; Examples and Details of Bins; Cost of Bins; Methods of Handling Materials. Part III, The Design of Grain Bins and Elevators: Types of Grain Elevators; Stresses in Grain Bins; Experiments on the Pressure of Grain in Deep Bins; The Design of Grain Bins and Elevators; Examples of Grain Elevators; Cost of Grain Bins and Elevators. Appendix I, Concrete Plain and Reinforced; Appendix II, Definitions of Masonry Terms, etc.; Appendix III, Specifications for Material and Workmanship for Steel Structures; Index.

ELECTRO-ANALYSIS.

By Edgar F. Smith. Fifth Edition, Revised and Enlarged. Leather, 7½ x 5¼ in., illus., 11 + 332 pp. Philadelphia, P. Blakiston's Son & Co., 1911. $2.50.

This edition contains, it is stated, as new material, the essentials of all that has appeared upon electro-analysis during the last four years. After a brief discussion of the sources of electric current and methods of reducing and measuring it, the author describes the apparatus used in the Laboratory at the University of Pennsylvania. This is followed by a history of the introduction of the electric current into chemical analysis. The remainder of the book is devoted to detailed descriptions of forms of apparatus and the arrangements necessary to carry out metal determinations, together with a description of the details to be observed in the electrolytic precipitation of individual metals. The author states that he has not thought it advisable to modify the recommendation, made in previous editions, under the rapid methods for metal determination or those in which the mercury cup and rotating anode are used, beyond emphasizing ordinary care and the addition of data arising from experience. The wide utility of the mercury cup as well as that of the double-cup for estimating anions and for determining and separating alkali metals, is confirmed, it is stated, by daily studies in the Laboratory of the University of Pennsylvania, and the author hopes these methods will come into more extended use. The Chapter Headings are: Introduction; Sources of Electric Current; Reduction of the Current; Measuring Currents; an Electro-Chemical Laboratory; Historical Sketch; Theoretical Considerations; Rapid Precipitation of Metals in the Electrolytic Way; Use of Mercury Cathode; Determinations of Metals; Separation of Metals; Additional Remarks on Metal Separations; Determination of the Halogens in the Electrolytic Way; Special Application of the Rotating Anode and Mercury Cathode in Analysis; Oxidations by Means of the Electric Current; The Combustion of Organic Compounds; Index.

HENDRICKS' COMMERCIAL REGISTER OF THE UNITED STATES

For Buyers and Sellers. Twentieth Annual Edition. Cloth, 10½ x 7½ in., illus., 108 + 1419 pp. New York, Samuel E. Hendricks Co., 1911. $10.00.

This publication is stated to be a complete and reliable annual index of the architectural, mechanical, engineering, contracting, electrical, railroad, iron, steel, hardware, mining, mill, quarrying, exporting, and kindred industries, indispensable as a buyer's reference and for mailing purposes. It is said to contain more than 350 000 names and addresses, and upward of 37 000 business classifications, with full lists of the manufacturers of and dealers in everything used in the manufacture of material, machinery, and apparatus for these industries, from the raw material to the manufactured article, and from the producer to the consumer. The contents are arranged by subject, under which are given, in alphabetical order and in some cases by States and cities, the names and addresses of firms dealing in a particular article, and sometimes these are followed by detailed matter, titles of identification, trade names, etc. There is also an alphabetical list of advertisers, including the addresses of their domestic and foreign branches, and an index of 108 pages.

SUSPENSION BRIDGES AND CANTILEVERS:

Their Economic Proportions and Limiting Spans. By D. B. Steinman, Jun. Am. Soc. C. E. Van Nostrand's Science Series, No. 127. Cloth, 6 x 4 in., 185 pp. New York, D. Van Nostrand Company, 1911. 50 cents.

The author states that, owing to his inability to find, in recent engineering literature, any general comparison of the relative adaptability of cantilever and suspension bridges to long-span construction, and to the lack of adequate data from which limiting and economic spans for the two-bridge types can be deduced, he has undertaken to supply this deficiency and to determine as definitely as practicable the length of span at which the suspension bridge becomes economically superior to the cantilever. He has solved these problems, it is stated, by making designs and estimates of a wide range of cantilevers and suspension bridges, and deducing therefrom the laws of variation of weight and cost with length of span, thus establishing the relations between span and weight and fixing the maximum feasible span for each form of construction. The cost curves of the two types will indicate, it is stated, their comparative economy at different spans as well as the critical span of equal cost, and an estimate of the maximum probable traffic returns, compared with the costs of different spans, will determine the economic limiting length of each type. Methods of designing the different parts of the bridge structure, together with the determination of economic rise-ratio for suspension bridges, the minimum depth of stiffening trusses for adequate rigidity, the economic depth of stiffening truss, the best span-ratios and the minimum width for cantilevers, etc., are also stated to be included in the book. The Contents are: Introduction; Study of Suspension Bridges; Design of Suspension Bridges; Conclusions for Suspension Bridges; Study of Cantilevers; Design of Cantilevers; Conclusions for Cantilevers; Final Comparisons and Conclusions.

PRINCIPLES OF THERMODYNAMICS.

By G. A. Goodenough. Cloth, 9½ x 6¼ in., illus., 14 + 327 pp. New York, Henry Holt and Company, 1911. $3.50.

The purpose of this work, it is stated, is to provide a course in the principles of thermodynamics which will serve as an adequate foundation for the advanced study of heat engines. While emphasis is placed on the principles rather than on the applications of the subject, in the chapters on the technical applications, the underlying theory of various heat engines is stated to be quite fully developed. The discussion, however, is restricted to ideal cases, the questions of the design, operation, or performance of heat engines being reserved for a subsequent volume. The author states that he has applied his twelve years' experience in teaching to the arrangement of the subject-matter, and the method of presentation. The first six chapters are devoted to the development of the fundamental laws and the derivations of the general equations of thermodynamics. The remainder of the book relates to the laws of gases and gaseous mixtures and a discussion of the properties of saturated and superheated vapors, each subject being followed by its technical applications. Attention is called by the author to (1) the method of presenting the fundamental laws; (2) the discussion of saturated and superheated vapors; (3) the discussion of the flow of fluids and of throttling processes; (4) the treatment of gaseous mixtures; and (5) the note on the interpretation of differential expressions. Numerous solved problems are contained in the text, and at the end of each chapter, exercises are appended. There are also references to the treatment of topics in standard works and to original articles. The Contents are: Energy; Change of State, Thermal Capacities; The First Law of Thermodynamics; The Second Law of Thermodynamics; Temperature Entropy Representation; General Equations of Thermodynamics; Properties of Gases; Gaseous Compounds and Mixtures, Combustion; Technical Applications, Gaseous Media; Saturated Vapors; Superheated Vapors; Mixtures of Gases and Vapors; The Flow of Fluids; Throttling Processes; Technical Applications of Vapor Media: The Steam Engine, The Steam Turbine, Refrigeration with Vapor Media; Index.

THE NAVIGABLE RHINE.

By Edwin J. Clapp. Cloth, 8¼ x 5¼ in., illus., 17 + 134 pp. Boston and New York, Houghton, Mifflin Company, 1911. $1.00.

In June, 1910, this book was awarded the first prize in Class A of the prize essays offered annually by Messrs. Hart, Schaffner, and Marx, of Chicago, for the encouragement of the study of economics and commerical subjects among Americans. It is stated that it is a study of the internal waterways of Germany, especially of the Rhine, as this river is the chief waterway of Germany and Europe, in which the author traces the stages of development, namely, the mediæval staple and transfer right of the powerful cities along its banks, the competition of railway and river in the Nineteenth Century, the long struggle to free the river of the tolls that hampered it in this competition, etc. It also shows, as stated in a secondary title, how the development of shipping on the Rhine, is the basis of the prosperity of its commerce and its traffic in 1907. The Contents are: Bibliography; The Development of the Rhine's Commerce: The Rhine before 1800; The Liberation of the Rhine and the Present Status; The Development of Traffic on the Rhine in the Nineteenth Century. Causes for the Prosperity of Commerce on the Rhine: The Growing Predominance of Bulk Goods in Commerce; Improvements of the Channel and the Boats; Development of the Rhine's Sea and River Harbors; Development of Steamboat Companies and the Railroads. The Rhine's Traffic in 1907: River Traffic of Rhine Seaports and Traffic on the German-Dutch Border; Traffic in German Rhine Harbors. The Rhine's Competitors: The Rhine's Competitors; Water Rates; Rhine and Mississippi; Index.

Gifts have also been received from the following:

Alabama-Bureau of Mines. 1 pam.
Alabama-Geol. Survey. 2 pam.
Alabama-State Auditor. 1 vol.
Am. Inst. of Chemical Engrs. 1 bound vol.
Assoc. of Ontario Land Surveyors. 1 vol.
Atlantic Deeper Waterways Assoc. 1 pam.
Barney, William J. 14 pam.
Bates, Onward. 2 pam.
Bogue, Virgil G. 1 vol.
Brockton, Mass.-Board of Health. 8 pam.
Brooklyn Engrs.' Club. 1 bound vol.
California-State Forester. 1 map.
Canadian Soc. of Civ. Engrs. 1 vol., 2 pam.
Chicago & Eastern R. R. Co. 1 pam.
Chicago, Ill.-Bureau of Public Efficiency. 1 pam.
Colorado-State Insp. of Coal Mines. 2 vols.
Colorado Univ. 3 pam.
Cornell Univ. 1 pam.
Dartmouth Coll.-Thayer School of Civ. Eng. 1 pam.
Eastern Bengal and Assam, India-Public Works Dept. 1 pam.
Edmonton, Alberta-City Commrs. 9 pam.
Eng. Assoc. of the South. 1 vol.
Estes, L. A. 2 pam.
Ferrocarriles Nacionales de Mexico. 1 pam.
Florida-Comptroller. 1 bound vol., 5 vol.
Germany-Preussische Landesanstalt für Gewässerkunde. 14 vol.
Gloucester, Mass.-Mayor. 4 bound vol.
Godfrey, Edward. 1 bound vol.
Great Britain-Patent Office. 1 vol.
Great Britain-Port of London Authority. 1 vol.
Harbison-Walker Refractories Co. 1 bound vol.
Hawaii-Board of Agri. and Forestry. 1 pam.
Illinois-Bureau of Labor Statistics. 1 bound vol.
Institution of Civ. Engrs. 1 bound vol.
Iowa-Secy. of State. 1 vol.
Iron and Steel Inst. 1 bound vol.
Kansas-Public Utilities Comm. 1 pam.
Koninklijk Instituut van Ingenieurs. 1 pam.
Madras, India-Public Works Dept. 1 pam.
Manchester, England-Cleansing Dept. 7 pam.
Massachusetts-Joint Board of Met. Impvts. 1 vol.
Medford, Mass.-City Engr. 4 vols., 12 pam.
Michigan-Secy. of State. 1 bound vol.
Milwaukee, Wis.-Bureau of Economy and Efficiency. 2 pam.
Milwaukee, Wis.-City Engr. 1 bound vol.
Minnesota, Univ. of. 2 vol.
Mississippi-State Geol. Survey. 1 bound vol.
Missouri, Univ. of. 1 vol.
Montana-State Engr. 1 pam.
Moyer, Albert. 1 pam.
Muenscher, E. W. 3 bound vol., 311 pam.
Nat. Assoc. of Cotton Manufacturers. 1 vol.
National Fire Protection Assoc. 1 pam.
Nebraska, Univ. of. 1 vol.
New London, Conn.-Board of Water and Sewer Commrs. 1 pam.
New South Wales-Government Statistician. 1 bound vol.
New York-State Barge Canal Terminal Comm. 1 pam.
New York-State Comm. of Highways. 1 bound vol.
New York State-Public Service Comm., First Dist. 1 bound vol.
New York City Record. 1 bound vol.
Ohio-State Min. Dept. 1 bound vol.
Ohio Eng. Soc. 2 pam.
Oklahoma-Geol. Surv. 2 pam.
Ontario, Canada-Bureau of Mines. 1 bound vol.
Ontario, Canada-Registrar-General. 1 vol.
Oregon, Univ of. 1 pam.
Pennsylvania State Coll. 1 vol.
Philadelphia, Pa.-Bureau of Surveys. 1 bound vol.
Philadelphia, Pa.-Bureau of Water. 1 bound vol.
Philippine Islands-Director of Public Works. 1 pam.
Philippine Islands-Weather Bureau. 1 pam.
Pittsburg, Pa.-Bureau of Water. 1 vol.
Polk, W. Anderson. 1 pam.
Porto Rico-Secy. 1 pam.
Queensland-Commr. of Rys. 1 pam.
Rhode Island-State Board of Health. 1 bound vol.
Royal Inst. of British Archts. 1 vol.
St. Louis, Rocky Mountain & Pacific Co. 3 pam.

Sherrerd, Morris R. 3 pam.
South Australia-Rys. Commr. 1 pam.
Stewart, John. 1 bound vol.
Tennessee-State Board of Health. 1 bound vol., 1 vol.
Texas, Univ. of. 1 pam.
Thompson, Slason. 1 bound vol.
Toledo, St. Louis & Western R. R. Co. 1 pam.
Union College. 1 vol.
Union Pacific R. R. Co. 2 pam.
U. S.-Bureau of Insular Affairs. 1 pam.
U. S.-Bureau of Mines. 1 vol., 2 pam.
U. S.-Bureau of Statistics. 2 pam.
U. S.-Chf. of Engrs. 13 pam.
U. S.-Chf. of Ordnance. 1 bound vol.
U. S.-Coast and Geodetic Survey. 1 vol.
U. S.-Commr. of Corporations. 1 vol.
U. S.-Geol. Survey. 1 pam.
U. S.-Interstate Commerce Comm. 21 pam.
U. S.-Isthmian Canal Comm. 1 bound vol., 2 vol.
U. S.-National Museum. 1 bound vol.
U. S.-Office of Exper. Stations. 2 pam.
U. S.-Office of Public Roads. 3 pam.
U. S.-Public Health and Marine Hospital Service. 1 pam.
U. S.-Senate. 1 bound vol.
Vierendeel, A. 2 pam.
Virginia-Geol. Survey. 1 pam.
Virginia-State Corporation Comm. 2 bound vol.
Washington-State Board of Health. 1 pam.
Western Australia-Govt. Rys. 1 pam.
Wisconsin-State Board of Health. 2 bound vol.
Wisner, George M. 1 pam.
Wyoming, Univ. of-Exper. Station. 1 vol., 1 pam.

BY PURCHASE

The Port of Hamburg. By Edwin J. Clapp. Yale University Press, New Haven; Henry Frowde, London, Oxford University Press, 1911.

Royal Commission on Sewage Disposal: Seventh Report of the Commissioners; Vol. 2, Pt. 1. Wyman & Sons, Limited, London, 1911.

Electric Railway Engineering. By C. Francis Harding. McGraw-Hill Book Company, New York and London, 1911.

The Reduction of Domestic Mosquitos: Instructions for the Use of Municipalities, Town Councils, Health Officers, Sanitary Inspectors, and Residents in Warm Climates. By Edward Halford Ross. P. Blakiston's Son & Co., Philadelphia, 1911.

Principles of Electrical Engineering. By Harold Pender. McGraw-Hill Book Company, New York and London, 1911.

Practical Thermodynamics, A Treatise on the Theory and Design of Heat Engines, Refrigeration Machinery, and Other Power-Plant Apparatus. By Forrest E. Cardullo. McGraw-Hill Book Company, New York and London, 1911.

Electric Traction for Railway Trains, A Book for Students, Electrical and Mechanical Engineers, Superintendents of Motive Power, and Others Interested in the Development of Electric Traction for Railway Train Service. By Edward P. Burch. McGraw-Hill Book Company, New York and London, 1911.

Shipyard Practice as Applied to Warship Construction. By Neil J. McDermaid. Longmans, Green, and Co., New York, London, Bombay, and Calcutta, 1911.

Handbuch der Hygiene. Von M. Rubner, M. V. Gruber, and M. Ficker. II. Band, 2. Abteilung: Wasser und Abwasser. S. Hirzel, Leipzig, 1911.

Building in London, A Treatise on the Law and Practice Affecting the Erection and Maintenance of Buildings in the Metropolis. By Horace Cubitt. With Special Chapters Dealing Respectively with the Cost of Building Work In and Around London by H. J. Leaning and The Valuation, Development, and Rating of London Property by Sydney A. Smith. Constable & Company, Limited, London, 1911.

Chemins de Fer Funiculaires Transports Aériens. Par A. Levy-Lambert. Deuxième Edition. Gauthier-Villars, Imprimeur-Libraire, Paris.

Iowa Geological Survey: Annual Reports for the Years 1892–1900, Inclusive, with Accompanying Papers; Vols. 1, 3–11. Iowa Geological Survey, Des Moines, 1893–1901.

Forscherarbeiten auf dem Gebiete des Eisenbetons: Schwimmkörper aus Eisenbeton, von Walther Stross. Wilhelm Ernst & Sohn, Berlin, 1911.

Fortschritte der Technik: Jahrbuch des Internationalen Institutes für Techno-Bibliographie, 1909. Bibliographischer Zentral, Berlin.

SUMMARY OF ACCESSIONS

(From November 7th to December 8th, 1911)

Donations (including 253 duplicates)	563
By purchase	23
Total	586

MEMBERSHIP

ADDITIONS

(From November 8th to December 12th, 1911)

MEMBERS		Date of Membership.
Allen, Charles Kyes. Res. Engr. for Waddell & Harrington, 283 Oregon St., Portland, Ore.		Oct. 31, 1911
Dozier, Melville, Jr. Pres., Dozier Constr. & Eng. Co., 607 Nicolaus Bldg., Sacramento, Cal.		Oct. 31, 1911
Foster, Robert Arnold. P. O. Box 218, Lewiston, Idaho.		Oct. 31, 1911
Francisco, Ferris LeRoy. Chf. Engr., Am. Tobacco Co., 111 Fifth Ave., Room 1008, New York City		Dec. 5, 1911
Higgins, Charles Houchin. Cons. Engr., 15 Exchange Pl., Jersey City, N. J.	Jun. Assoc. M. M.	Jan. 2, 1906 April 1, 1908 Dec. 5, 1911
McGonigle, Charles Joseph. Contr. Mgr., Milliken Bros., Inc., 815 Chamber of Commerce Bldg., Portland, Ore.	Assoc. M. M.	May 6, 1908 Oct. 31, 1911
Naylor, Ezra Booth. 436 Park Hill Ave., Yonkers, N. Y.		Sept. 5, 1911
Pendergrass, Robert Allen. Chf. Draftsman, Rankin Plant, McClintic-Marshall Constr. Co., 105 Savannah Ave., Wilkinsburg, Pa.	Assoc. M. M.	June 3, 1908 Oct. 31, 1911
Reich, Phillip Jacob. Engr., Toledo Plant, Am. Bridge Co., Toledo, Ohio	Assoc. M. M.	June 5, 1907 Dec. 5, 1911
Scott, Dunbar Doolittle. Cons. Engr., Bausch & Lomb Optical Co. (Res., 238 Milburn St.), Rochester, N. Y.		Dec. 5, 1911
Stockett, Alfred Walton. Gen. Mgr., The Simmer & Jock Proprietary Mines, Ltd., P. O. Box 192, Germiston, Transvaal, South Africa	Assoc. M. M.	Jan. 1, 1896 Sept. 5, 1911
Storrs, Harry Asahel. Treas., The Field, Fellows & Hinderlider Eng. Co., 435 Century Bldg., Denver, Colo.		June 6, 1911
Thomes, Edwin Howard. Asst. Engr., Bureau of Highways, Borough of Queens, New York City; Res., 161 Willett St., Jamaica, N. Y.	Assoc. M. M.	Dec. 6, 1899 Dec. 5, 1911
Vauclain, Samuel Matthews. Vice-Pres., Baldwin Locomotive Works, 500 North Broad St., Philadelphia, Pa.		Dec. 5, 1911
Williams, Frederick Charles. Cons. Engr., 425 Cuyahoga Bldg., Cleveland, Ohio		May 2, 1911

ASSOCIATE MEMBERS

		Date of Membership.
Ashbrook, Chester Daniel. Res. Engr., Canadian Northern Ontario R. R., Pearl, Ont., Canada	Jun. Assoc. M.	May 4, 1909 June 6, 1911
Batson, Charles Drewry. Asst. Engr., Water-Works Dept., 912 Goodrich Ave., St. Paul, Minn		Oct. 3, 1911
Beebe, James Wilbur. Prescott, Ark		Dec. 5, 1911
Bishop, Lyman Edgar. Location Engr., The Goldsborough Co., First National Bank Bldg., Denver, Colo	Jun. Assoc. M.	May 4, 1909 Oct. 31, 1911
Blair, Clarence Moore. 99 Norton St., New Haven, Conn		Dec. 5, 1911
Burnette, Chauncey Allison. (Murray & Burnette), 527 Central Bldg., Seattle, Wash		June 6, 1911
Carbajal, Fernando. P. O. Box 315, Lima, Peru	Jun. Assoc. M.	Jan. 7, 1908 Oct. 3, 1911
Clack, James Morgan. City Engr., Nevada, Mo		Oct. 31, 1911
Dahlin, John Edward Bartholomew. Designer, Bridge Dept., Chicago & North Western Ry. Co., The Ridgewood Bldg., Edison Park, Chicago, Ill		Oct. 31, 1911
Digby, Joseph Herbert. Care, Madeira-Mamoré Ry. Co., Itacoatiara, Amazonas, Brazil		Oct. 3, 1911
Edwards, William Watkyn. Chf. Engr., Quesnelle Hydraulic Gold Min. Co., Hydraulic, Carriboo Dist., B. C., Canada		Oct. 3, 1911
Elam, William Earle. Asst. Engr., Mississippi Levee Board, Greenville, Miss.	Jun. Assoc. M.	Feb. 6, 1906 Oct. 31, 1911
Ellsworth, Lincoln. Engr., Yale Expedition to Peru, The Florence, Missoula, Mont	Jun. Assoc. M.	May 5, 1908 Oct. 3, 1911
Floyd, Earl Nesby. With Pittsburg (Pa.), Testing Laboratory, South Pittsburg, Tenn		Oct. 3, 1911
Geddes, Donald Young. 148 North 6th St., Zanesville, Ohio		Dec. 5, 1911
Gowdy, Roy Cotsworth. Chf. Engr., Ft. Worth & Denver City Ry. and Wichita Val. Lines, 514 Ft. Worth National Bank Bldg., Fort Worth, Tex		Oct. 31, 1911
Greene, Lloyd Woolsey. Asst. Engr., N. Y. C. & H. R. R. R. (Res., 132 East 8th St.), Oswego, N. Y	Jun. Assoc. M.	Sept. 1, 1908 Oct. 31, 1911
Hammond, Lester Clark. Oyster Bay, N. Y		Oct. 31, 1911
Holdredge, Neil Cummings. 154 East 175th St., New York City		Oct. 31, 1911
Hulburd, Lucius Sanford. Res. Engr., New York State Barge Canal, Seneca Falls, N. Y		Oct. 31, 1911

ASSOCIATE MEMBERS (*Continued*)

		Date of Membership.
Hunter, Leroy Littlefield. Asst. Engr., Constr. Div., Bureau of Eng., 807 City Hall, Chicago, Ill.	Jun. Assoc. M.	Jan. 5, 1904 Dec. 5, 1911
Jarvis, Clarence Sylvester. U. S. Deputy Mineral Surv., Provo, Utah	Jun. Assoc. M.	Sept. 4, 1906 Sept. 5, 1911
Jones, William Nelson. Supt., Filtration Plant, Care, City Engr., Minneapolis, Minn.		Oct. 31, 1911
Langley, Clarence Erwin. Junior Engr., Isthmian Canal Comm., Gatun, Canal Zone, Panama		Oct. 31, 1911
Lee, Charles Avery. Care, Vancouver Power Co., Vancouver, B. C., Canada		Oct. 31, 1911
McDonald, Harry L. Asst. Topographer, U. S. Geological Survey, Wenatchee, Wash.		Oct. 31, 1911
McGlashan, Harry Deyoe. Acting Dist. Engr., U. S. Geological Survey, 505 U. S. Custom House, San Francisco (Res., 2315 Hilgard Ave., Berkeley), Cal.		Oct. 31, 1911
Morton, Leon Lincoln. Asst. Engr., Kansas City Southern Ry. Co., Texarkana, Tex.		Oct. 31, 1911
Nelson, Oscar Benjamin. 942 Seventeenth Ave., S. E., Minneapolis, Minn.		Oct. 3, 1911
Park, Charles Abraham. Lighthouse Supt., 11th U. S. Lighthouse Dist., Detroit, Mich.		Oct. 31, 1911
Parker, Glenn Lane. Asst. Engr., U. S. Geological Survey, 208 Tilford Bldg., Portland, Ore.		June 30, 1911
Pendleton, David Elliott. Engr. in M. of W. Dept., Houston & Tex. Cent. R. R., Ennis, Tex.	Jun. Assoc. M.	Jan. 2, 1906 Oct. 31, 1911
Perry, Charles Edwards. (Vrooman & Perry), Canajoharie, N. Y.		Sept. 5, 1911
Peterson, Otto Wallace. Lone Pine, Cal.		Oct. 31, 1911
Purver, George Moses. Cons. Engr., 146 East 8th St., Brooklyn, N. Y.		Oct. 3, 1911
Stevens, Arthur Leslie. Asst. Engr., Sewer Maintenance Dept., 319 City Hall (Res., 5600 Linwood Ave.), Cleveland, Ohio		Oct. 31, 1911
Stewart, Benjamin Franklin, Jr. City Engr., Parkersburg, W. Va.		Dec. 5, 1911
Thompson, Edward Percival. Chf. Engr., Mindoro Development Co., 970 Calle Real, Manila, Philippine Islands	Assoc. Assoc. M.	June 5, 1907 Sept. 5, 1911
Tisdale, Charles Harry. U. S. Junior Engr., Hales Bar, Guild, Tenn.		Oct. 31, 1911
Vilar y Boy, Santiago. Asst. Engr., M. of W. Dept., Guatemala Ry. Co., Guatemala City, Guatemala		Oct. 31, 1911

ASSOCIATE MEMBERS (*Continued*)

	Date of Membership.
Wadhams, Joseph Palmer. Asst. Engr., N. Y., N. H. & H. R. R. Co., New Rochelle, N. Y.	Oct. 31, 1911
Warfield, Ralph Mervine. Navy Yard, Bremerton, Wash.	Sept. 5, 1911
Witt, Jackson Franklin. County Engr., Dallas County, Dallas, Tex.	Oct. 31, 1911
Worley, Albert Harrison. In Chg., Drafting Room, Hedrick & Cochrane, 3622 Garfield Ave., Kansas City, Mo.	Oct. 31, 1911
Zipser, Morris Ernest. Asst. Engr., Board of Water Supply of New York, 236 Main St., Poughkeepsie, N. Y.	Oct. 31, 1911

ASSOCIATE

Philbrick, Burton Garfield. Bacteriologist, Eaton-Philbrick Laboratories, 444 Market St., San Francisco, Cal.	Oct. 31, 1911

JUNIORS

Alderman, Ernest Samuel. 25 North Dwight Way, Berkeley, Cal.	Oct. 3, 1911
Amadon, Frederick Webber. Asst. Engr., N. Y., N. H. & H. R. R., Room 308, Office Bldg., New Haven, Conn.	June 30, 1911
Bossert, Carl Donald. Asst. County Engr., Columbiana County, Washingtonville, Ohio	Oct. 31, 1911
Buck, Ross Judson. Chf. of Survey Party No. 12, Bureau of Lands, Manila, Philippine Islands	June 30. 1911
Clift, William Brooks. 240 McCallie Ave., Chattanooga, Tenn.	Oct. 31, 1911
Cole, Ernest Delavan. P. O. Box 448, Coalinga, Cal.	Oct. 31, 1911
Cunningham, William Augustine. 193A Schaeffer St., Brooklyn, N. Y.	June 30, 1911
Cykler, Emil Frank. Structural Engr., with H. J. Brunnier, 1739 Euclid Ave., Berkeley, Cal.	Oct. 31, 1911
Dow, Edwin Arthur. 320 East Davenport St., Iowa City, Iowa	Oct. 31, 1911
Dunlap, Walter Hanna. The Consolidated Coal Co., Jenkins, Ky.	Oct. 31, 1911
Eberly, Virgil Allen. Care, C. M. Saville, Culebra, Canal Zone, Panama	June 6, 1911
Gardner, Henry James, Jr. Prin. Asst. Engr., Ricker & Minniss, 702 Ellicott Sq., Buffalo, N. Y.	Oct. 31, 1911
Gurney, Lester. Draftsman-Instrumentman with Western Div., Cape Cod Constr. Co., Bourne, Mass.	Dec. 5, 1911
Hjorth, Lauritz Rasmus. Draftsman, Cleveland & Cameron, 506 Winch Bldg., Vancouver, B. C., Canada	June 30, 1911
Jones, William Henry. 446 Langside St., Winnipeg, Man., Canada	Oct. 31, 1911

JUNIORS (*Continued*)	Date of Membership.
Klingner, Louis William. Res. Engr., Double Track Constr., Canadian Pacific Ry., from Smith's Falls West, Box 57, Perth, Ont., Canada	Oct. 31, 1911
McDowell, William Hunter. Box 15, Narberth, Pa	Dec. 5, 1911
Monk, Percy Shelley. Junior Engr., U. S. Geological Survey, Federal Bldg., Newport, Ky	June 30, 1911
Nelson, Ernest Benjamin. Box 443, Cristobal, Canal Zone, Panama	Oct. 31, 1911
Powers, Louis. Computer, R. R. and Canal Revaluation, State of New Jersey, 901 Madison Ave., Elizabeth, N. J	Sept. 5, 1911
Smith, Clarence Urling. 117 West 16th Ave., Spokane, Wash	Sept. 5, 1911
Turner, Arthur Hubesty. Asst. Engr., Southern Ferro-Concrete Co., 344 Equitable Bldg., Atlanta, Ga	Oct. 3, 1911
Vanneman, Arthur Vosbury. (Torrington & Vanneman), Newburg, W. Va	June 6, 1911
Wilkins, Homer Jenner. 1819 West 9th St., Oklahoma City, Okla	Oct. 31, 1911
Wilson, Claude Thomas. 215 West 23d St., New York City	Dec. 5, 1911

RESIGNATION

ASSOCIATE MEMBER	Date of Resignation.
Lorenz, George Benjamin	Oct. 31, 1911

DEATHS

Davidson, George. Elected Honorary Member, May 5th, 1897; died December 2d, 1911.

Ferrier, Joseph James. Elected Junior, December 3d, 1907; died October 30th, 1911.

Total Membership of the Society, December 12th, 1911, 6 339.

MONTHLY LIST OF RECENT ENGINEERING ARTICLES OF INTEREST

(November 7th to December 8th, 1911)

NOTE.—*This list is published for the purpose of placing before the members of the Society, the titles of current engineering articles, which can be referred to in any available engineering library, or can be procured by addressing the publication directly, the address and price being given wherever possible.*

LIST OF PUBLICATIONS

In the subjoined list of articles, references are given by the number prefixed to each journal in this list:

(1) *Journal,* Assoc. Eng. Soc., 31 Milk St., Boston, Mass., 30c.
(2) *Proceedings,* Engrs. Club of Phila., 1317 Spruce St., Philadelphia, Pa.
(3) *Journal,* Franklin Inst., Philadelphia, Pa., 50c.
(4) *Journal,* Western Soc. of Engrs., Monadnock Blk., Chicago, Ill.
(5) *Transactions,* Can. Soc. C. E., Montreal, Que., Canada.
(6) *School of Mines Quarterly.* Columbia Univ., New York City, 50c.
(8) *Stevens Institute Indicator,* Stevens Inst., Hoboken, N. J., 50c.
(9) *Engineering Magazine,* New York City, 25c.
(10) *Cassier's Magazine,* New York City, 25c.
(11) *Engineering* (London), W. H. Wiley, New York City, 25c.
(12) *The Engineer* (London), International News Co., New York City, 35c.
(13) *Engineering News,* New York City, 15c.
(14) *The Engineering Record,* New York City, 12c.
(15) *Railway Age Gazette,* New York City, 15c.
(16) *Engineering and Mining Journal,* New York City, 15c.
(17) *Electric Railway Journal,* New York City, 10c.
(18) *Railway and Engineering Review,* Chicago, Ill., 10c.
(19) *Scientific American Supplement,* New York City, 10c.
(20) *Iron Age,* New York City, 10c.
(21) *Railway Engineer,* London, England, 25c.
(22) *Iron and Coal Trades Review,* London, England, 25c.
(23) *Bulletin,* American Iron and Steel Assoc., Philadelphia, Pa.
(24) *American Gas Light Journal,* New York City, 10c.
(25) *American Engineer,* New York City, 20c.
(26) *Electrical Review,* London, England.
(27) *Electrical World,* New York City, 10c.
(28) *Journal,* New England Water-Works Assoc., Boston, Mass., $1.
(29) *Journal,* Royal Society of Arts, London, England, 15c.
(30) *Annales des Travaux Publics de Belgique,* Brussels, Belgium.
(31) *Annales* de l'Assoc. des Ing. Sortis des Ecoles Spéciales de Gand, Brussels, Belgium.
(32) *Mémoires et Compte Rendu des Travaux,* Soc. Ing. Civ. de France, Paris, France.
(33) *Le Génie Civil,* Paris, France.
(34) *Portefeuille Economiques des Machines,* Paris, France.
(35) *Nouvelles Annales de la Construction,* Paris, France.
(37) *Revue de Mécanique,* Paris, France.
(38) *Revue Générale des Chemins de Fer et des Tramways,* Paris, France.
(41) *Modern Machinery,* Chicago, Ill., 10c.
(42) *Proceedings,* Am. Inst. Elec. Engrs., New York City, 50c.
(43) *Annales des Ponts et Chaussées,* Paris, France.
(44) *Journal,* Military Service Institution, Governors Island, New York Harbor, 50c.
(45) *Mines and Minerals,* Scranton, Pa., 20c.
(46) *Scientific American,* New York City, 8c.
(47) *Mechanical Engineer,* Manchester, England.
(48) *Zeitschrift,* Verein Deutscher Ingenieure, Berlin, Germany.
(49) *Zeitschrift für Bauwesen,* Berlin, Germany.
(50) *Stahl und Eisen,* Düsseldorf, Germany.
(51) *Deutsche Bauzeitung,* Berlin, Germany.
(52) *Rigasche Industrie-Zeitung,* Riga, Russia.
(53) *Zeitschrift,* Oesterreichischer Ingenieur und Architekten Verein, Vienna, Austria.
(54) *Transactions,* Am. Soc. C. E., New York City, $4.
(55) *Transactions,* Am. Soc. M. E., New York City, $10.
(56) *Transactions,* Am. Inst. Min. Engrs., New York City, $5.

(57) *Colliery Guardian,* London, England.

(58) *Proceedings,* Engrs.' Soc. W. Pa., 803 Fulton Bldg., Pittsburg, Pa., 50c.

(59) *Transactions,* Mining Inst. of Scotland, London and Newcastle-upon-Tyne, England.

(60) *Municipal Engineering,* Indianapolis, Ind., 25c.

(61) *Proceedings,* Western Railway Club, 225 Dearborn St., Chicago, Ill., 25c.

(62) *Industrial World,* 59 Ninth St., Pittsburg, Pa.

(63) *Minutes of Proceedings,* Inst. C. E., London, England.

(64) *Power,* New York City, 20c.

(65) *Official Proceedings,* New York Railroad Club, Brooklyn, N. Y., 15c.

(66) *Journal of Gas Lighting,* London, England, 15c.

(67) *Cement and Engineering News,* Chicago, Ill., 25c.

(68) *Mining Journal,* London, England.

(70) *Engineering Review,* New York City, 10c.

(71) *Journal,* Iron and Steel Inst., London, England.

(71*a*) *Carnegie Scholarship Memoirs,* Iron and Steel Inst., London, England.

(73) *Electrician,* London, England, 18c.

(74) *Transactions,* Inst. of Min. and Metal., London, England.

(75) *Proceedings,* Inst. of Mech. Engrs., London, England.

(76) *Brick,* Chicago, Ill., 10c.

(77) *Journal,* Inst. Elec. Engrs., London, England.

(78) *Beton und Eisen,* Vienna, Austria.

(79) *Forscherarbeiten,* Vienna, Austria.

(80) *Tonindustrie Zeitung,* Berlin, Germany.

(81) *Zeitschrift für Architektur und Ingenieurwesen,* Wiesbaden, Germany.

(83) *Progressive Age,* New York City, 15c.

(84) *Le Ciment,* Paris, France.

(85) *Proceedings* Am. Ry. Eng. and M. of W. Assoc., Chicago, Ill.

(86) *Engineering-Contracting,* Chicago, Ill., 10c.

(87) *Roadmaster and Foreman,* Chicago, Ill., 10c.

(88) *Bulletin* of the International Ry. Congress Assoc., Brussels, Belgium.

(89) *Proceedings,* Am. Soc. for Testing Materials, Philadelphia, Pa.

(90) *Transactions,* Inst. of Naval Archts., London, England.

(91) *Transactions,* Soc. Naval Archts. and Marine Engrs., New York City.

(92) *Bulletin,* Soc. d'Encouragement pour l'Industrie Nationale, Paris, France.

(93) *Revue de Métallurgie,* Paris, France, 4 fr. 50.

(94) *The Boiler Maker,* New York City, 10c.

(95) *International Marine Engineering,* New York City, 20c.

(96) *Canadian Engineer,* Toronto, Ont., Canada, 15c.

(98) *Journal,* Engrs. Soc. Pa., 219 Market St., Harrisburg, Pa., 30c.

(99) *Proceedings,* Am. Soc. of Municipal Improvements, New York City, $1.50.

(100) *Professional Memoirs,* Corps of Engrs., U. S. A., Washington, D. C., $1.

(101) *Metal Worker,* New York City, 10c.

(102) *Organ für die Fortschritte des Eisenbahnwesens,* Wiesbaden, Germany.

(103) *Mining and Scientific Press,* San Francisco, Cal., 10c.

(104) *The Surveyor and Municipal and County Engineer,* London, England, 6d.

(105) *Metallurgical and Chemical Engineering,* New York City, 25c.

(106) *Transactions,* Inst. of Mining Engrs., London, England, 6 shillings.

(107) *Schweizerische Bauzeitung,* Zürich, Switzerland.

(108) *Southern Machinery,* Atlanta, Ga., 10c.

LIST OF ARTICLES.

Bridges.

Influence-Diagrams for Continuous Girders.* Frederick Charles Lea. (63) Vol. 185.

Remodeling an Old Steel Bridge.* Wm. Russell Smith, Jr. (98) Nov.

New Bridge Over the River Towy at Carmarthen.* (12) Nov. 3.

The Great Bridge Across the Lower Ganges, India.* (From *Indian and Eastern Engineer.*) (13) Nov. 9.

Steel Arch Bridge Over the East River, New York.* (15) Nov. 10.

Erection of the Pend Oreille River Bridge.* (14) Nov. 11.

Notes on the Quebec Bridge Competition.* Gustav Lindenthal. (13) Serial beginning Nov. 16.

A Reinforced Concrete Fender Pier.* C. E. Smith. (14) Nov. 18.

Erecting Street Platforms for the Pennsylvania Terminal, New York (Bridges over streets).* (14) Nov. 18.

The Plate Girder Spans of the Passyunk Avenue Bridge.* (14) Nov. 25.

A 162-Foot Wooden Truss for Construction Work; Howe Trusses Built of Planks Nailed Together and Rolled Longitudinally into Place.* (14) Nov. 25.

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*Illustrated.

Bridges—(Continued).

The 328-Ft. Reinforced-Concrete Arch Bridge Across the Tiber at Rome.* (13) Nov. 30.
The Dan River Concrete Highway Bridge in Virginia.* (14) Dec. 2.
Reconstruction of Bridge 298, New York Central Railroad—Concreting in Cold Weather.* Charles E. Anderson. (86) Dec. 6.
A Novel Form of Reinforced Concrete Arch Bridge Built in Thuringia, Germany.* (86) Dec. 6.
The Steel Arch Bridge Over the St. Croix River; Minneapolis, St. Paul & Sault Ste. Marie Ry.* Pierce P. Furber. (86) Dec. 6.
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*Illustrated.

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SPECIFICATIONS FOR THE DESIGN OF BRIDGES AND SUBWAYS.*

By Henry B. Seaman, M. Am. Soc. C. E.

In connection with his duties as Consulting Engineer to the Department of Bridges, New York City, in 1906, the writer found occasion to take up the revision of the specifications for the design of bridges, in order that a single specification might cover the general work of the Department. The bridges of the city varied in length of span from 16 to 1 600 ft., and were classed as either "long-span" or "short-span," there being none of such intermediate length as would question the class to which it belonged.

It had been the practice of the Department, as it had been the general practice elsewhere, to use a special specification for each bridge, conforming to the particular conditions of span and loading. For short-span bridges, where the live load was heavy and frequent, the allowable unit strains on the material were comparatively small, while on the longer spans, where the live load was more diffused and less frequent, the allowable strains were correspondingly increased. In spans of extreme length, where live-load congestion rarely occurs and is slowly applied, the allowable live-load strains may equal those permitted for dead load.

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* This paper will not be presented at any meeting, but written communications on the subject are invited for publication with it in *Transactions*.

In the *Proceedings* of this Society, the Papers and the Discussions on Papers will hereafter be printed so that each will commence on an odd-numbered page. This is done by special request, in order to enable members who wish to do so to separate the Papers and Discussions for filing under various engineering subjects.

Although the short-span bridges of the Department were at that time designed somewhat promiscuously—each designer selecting his own specification—the long spans had received more careful attention, and were designed under the recommendations of a Board of Engineers, composed of George S. Morison, Henry W. Hodge, Mansfield Merriman, Theodore Cooper, and C. C. Schneider, Members, Am. Soc. C. E. The recommendations provided for two different conditions of loading:

1st. An assumed, heavy, "congested" load, which would rarely, if ever, occur. For this loading the allowable unit strains were high, being the same as those allowed for dead load.

2d. An assumed "working" load, lighter and of more frequent occurrence than the "congested" load. For this loading the allowable strains were reduced one-half.

This double specification involved a double set of calculations throughout, and, as the computation of each set required some 6 months or more, the necessary time for the preliminary work alone was a serious matter.

Confronted by these conditions, the work of revising the specifications was undertaken. The designers of the Department were all called into consultation at various times, and, after several months of deliberation, a specification was outlined which was considered practicable. This was about ready for adoption when the writer left the Department of Bridges to enter the employ of the Public Service Commission for the First District of the State of New York, as Chief Engineer.

With the work of the Public Service Commission, this general specification was again taken up, for the purpose of extending its application to the broader field including subway construction. It was found suitable for that work, with but slight modification, and was finally adopted on January 1st, 1909, practically in the form here presented. For completeness of record, the items which were especially applicable to bridge construction are retained in this paper.

In taking up the theoretical consideration of this general specification, there seemed to be no sharp line of demarcation between "long-span" and "short-span" bridges. The two extremes appeared to merge gradually as the lengths of the spans changed. There was a fundamental underlying condition, however, which made a broad specification natural and fitting. This underlying condition was the fixed power of resistance of the materials of construction.

It seemed evident that, in order to produce a uniform specification, such elements as were constant in nature should remain constant in the specification, while those which varied under differing conditions, should be made to vary, with those conditions, in the specifications. The strength of materials—or their power of resistance—is definitely ascertained by experiment before use in construction, and does not vary with the length of span or with their location. Therefore, it may be the fixed quantity in the specification covering all spans.

Having established, as fixed, the strength of the material used, it is necessary that all forces to which the material may be subjected in the structure be equated to those under which the material was tested. As tests are usually made with quiescent loads, they correspond directly with the dead-load strains of the structure. The live-load strains, however, because of impact, oscillation, fatigue by repeated application, or other uncertainties, produce greater effect than the calculated strain would indicate, and must be augmented so that the increased result will represent a dead strain equivalent in its destructive effect to the live strain first calculated.

It will be recognized that the only reason why long and short spans have received different treatment heretofore has been because of the difference in the action of the live load on spans of different length, as the quality and strength of the material, and the effect of dead-load strain, are the same on whatever length of span. If, now, special attention be given to this difference of live load, provision may at once be made for this varying element. It seemed advisable, therefore, to outline a specification on the basis of dead-load strain only, and to equate all live-load strain, by changing it to that of a dead load of equivalent effect.

While the adaptation of this method of proportioning to long spans, and its use with high allowable unit strains is extreme, the principle is not new. It was in 1887 that C. C. Schneider, Past-President, Am. Soc. C. E., wrote his bridge specification for the Pencoyd Iron Company, in which he increased the live load by using an impact formula, and then allowed the same unit strains for both live and dead loads. The present suggestion is in the same direction, but proceeding one step farther. The formula for "equivalent static strain" will cover more uncertainties than the impact formula, and, therefore, should produce greater augmentation of the live load. At the same time, it will permit the use of a correspondingly greater allowable unit strain. With a proper increase of the formula, and of the allowable unit strain, it becomes applicable to long-span bridges, and thus covers the broader field of bridge construction.

It will be noticed that this method, by which the live-load strains are increased (instead of the old method, by which the allowable unit strains for live load were decreased), will produce greater counter-strains, and thus, by the better distribution of metal, will provide to some extent for the increased live load to which every important bridge may be subjected. The material in the structure will be distributed in the most economical manner possible; that is, only such as is absolutely necessary will be used to support the dead weight, while the remainder of the material is distributed so as to withstand best the live-load action—the destructive element in bridge service.

The selection of a formula for transforming the live strain into an "equivalent static" strain is the most complicated and the least satisfactory step in this method of design. It emphasizes the lack of definite information on the subject. This indefiniteness, however, is found in every method of design. It is no worse, either in character or in amount, when considered by itself, that when taken in connection with the dead load at every step in the design of spans of various lengths.

In reviewing the conditions to be covered by the formula, it is noted that a load instantaneously applied produces, with impact, double the strain of the same load at rest, and that by applying the load gradually the impact will be decreased. From this it is recognized that the impact effect of moving loads will be greater for short spans than for long ones.

Cars moving across a bridge rapidly will produce oscillation or vibration of the structure. This may vary with the speed of the moving car, the roughness of the track, the rigidity and adjustment of the structure, and possibly with the length of span.

Experiments show that a strain which is applied in continuous repetitions produces an effect about twice as destructive as a single application of the same strain. If the repetitions are not continuous, and the material is permitted to recover itself between applications, there will be a corresponding increase in the resisting power of the material. This has been described as the "fatigue of metals."

It is also noted that roadway or pedestrian traffic may become congested by panic or other cause. This congestion may be greater over small areas than over large ones—heavier per square foot on short than on long spans.

These are some of the uncertainties of live load which make it necessary to give special consideration to the resulting strains. This, as already described, may be done either by augmenting the live load, or by decreasing the allowable unit strains for the calculated live load. It is sometimes accomplished by a combination of these two methods. As the history of every important bridge shows that it is eventually loaded much in excess of the load for which it was designed, it seems preferable to augment the live-load strains rather than decrease the allowable unit strains.

The difficulty in selecting a formula arises from lack of information from which one might be produced. The experiments of J. E. Greiner, M. Am. Soc. C. E., are probably more complete than any yet made, but they do not justify any definite deductions. The effect of oscillations due to roughness of track is unknown, and, in considering loads of pedestrians and vehicles on highway bridges, the likelihood of local congestion over small areas is a matter of individual judgment, based on experiments showing widely differing results.

It seems necessary, therefore, to select some formula and then judge as to how closely its results correspond to what has heretofore been considered good practice, or to such experiments as we already have, leaving to the future such modification as further experiment or better reasoning may dictate.

It is evident that when the span is very long the application of the load is so gradual, and so rarely reaches the maximum, that any increase of live strain is unnecessary. On the other hand, for very short spans, impact alone will increase the strain 100%, and a further allowance should be made for the comparatively frequent repetition of maximum load and for other uncertainties. The impact formulas already in use may be kept in mind, but it must be recognized that the new formula for "static equivalent," which provides for more irregularities than mere impact, must give correspondingly greater increase of strain to produce the "static equivalent."

At what length of span the formula should begin to apply, is a matter of judgment; after conference,* it was assumed at 1 000 ft. It was also assumed that for very short spans the increase should not be less than 125 per cent. For intermediate spans, there seemed to be no better guide than the weights of the bridges already in service, or the results of the experiments by Mr. Greiner on the Baltimore and Ohio Railroad. On the diagram, Fig. 7, the results of these experiments have been plotted, and also various curves, for purposes of comparison. The curve, $S = 125 - \frac{1}{8}\sqrt{2\,000\,L - L^2}$, appears to give the best results, except for the span of 210 ft. On this particular span Mr. Greiner considers that the test may have been unreliable. This formula was accordingly adopted.

Allowable Strains.—If, by the formula for "static equivalent," provision is made for the most extreme loads that may occur, and if the assumed dead load is such that it will at no time be exceeded, we may conservatively use for dead load a unit strain equal to one-third of the ultimate strength, or two-thirds of the yield point, of the material. For medium steel of 60 000 lb. ultimate strength, the allowable dead-load unit strain would be 20 000 lb. per sq. in., in tension. The strains of different character, or on different material, would be deduced accordingly.

The entire specification was worked out on this dead-load unit basis, and even the foundations have been included in this method, permitting high unit pressures for only the most favorable conditions of quiescent load, and making provision for live load by use of the formula, as already mentioned.

The allowable unit strains and pressures are shown in kilo-pounds, or kip, indicated by 1 k. = 1 000 lb. The word "stress" has been avoided, because, outside of the class-room, it seems to lead to confusion. The writer has preferred the term "strain" for force, and the term "deformation" for change in dimension. The words "stress" and "strain" seem too nearly alike to have distinctive meanings, and on this account will probably continue to be used indiscriminately. For those who may prefer the word "stress," the change is easily made.

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* In formulating these specifications, the writer conferred freely with a number of professional friends (C. C. Schneider, J. E. Greiner, Mansfield Merriman, J. R. Worcester, F. C. Kunz, and P. L. Wölfel, Members, Am. Soc. C. E.), and many of the best points in the specifications are credited to their suggestions.

For columns, the Rankine formula has been used, as its derivation is more rational than the right line, and for the specimen tests shown on Figs. 8 to 18, the Rankine formula is much more satisfactory. A fine line is shown on several of these diagrams to indicate the formula of the specifications.

The tests made at Watertown Arsenal in 1908 and 1909 do not include long columns, and they indicate that the pin ends were somewhat fixed, possibly by pin friction, except the two tests of 10 100 and 13 130 lb. per sq. in. ultimate strength. These two tests are close to the established formulas.

For the bearing value of piles, it is well known that any formula is, at best, a rough approximation; yet it seems necessary to formulate some rule to assist the judgment. Piles may be divided into three classes, according to the method of driving or of resistance: 1st. Where the pile supports by end bearing alone, the resistance is the bearing area only. The strength of the pile, as a column, must not be exceeded. 2d. Where the pile is driven by blows of a hammer of definite weight, falling an ascertained height, the resistance may be calculated by the force required for penetration. Experience indicates that the actual resistance, after rest, usually exceeds that which is thus calculated. 3d. Where the method of driving prevents calculation, it is necessary to estimate the skin friction between the pile and the surrounding soil. This skin friction varies with different soils. It is proportional to the area of the exposed surface and to the pressure of the soil against the pile; this pressure, in turn, varies with the depth. To this skin friction may be added the resistance, if any, of the bearing end of the pile.

Live Loads.—Having adopted a formula for transforming live strain into an "equivalent static strain," and having also adopted the unit strains which may be allowed for dead load, it now becomes necessary to ascertain the live loads to which the structure may be subjected, bearing in mind that this live load will be such as may occur over spans of more than 1 000 ft., and that for shorter spans it will be properly augmented according to the formula for "static equivalent."

For railroad trains, the distribution proposed by Theodore Cooper, M. Am. Soc. C. E., has been very generally accepted in practice, and for this specification the concentrations corresponding to what is known as "*E*-50," with a train of 5 000 lb. per lin. ft. of track, have been adopted.

For elevated railway and subway trains, the weights in service in New York City are given in Table 1.

TABLE 1.—WEIGHTS OF CARS, ETC.

	Wooden motor car.	Steel motor car.	Trailer.
Length of body	49 ft. 2 in.	49 ft. 2 in.	46 ft. 7 in.
Distance between centers of trucks	33 " 6 "	33 " 6 "	32 " 3 "
Truck wheel base	6 " 4 "	6 " 4 "	6 " 0 "
Distance between centers of wheels of adjoining cars.	9 " 4 "	9 " 4 "	9 " 4 "
Weight on front truck	52 100 lb.	52 100 lb.	29 500 lb.
Weight on rear truck	38 900 "	41 400 "	29 500 "
Total weight	91 000 "	93 500 "	59 000 "
Weight, per linear foot	1 820 "	1 920 "	1 200 "

The elevated railway cars of the Brooklyn Rapid Transit Railroad weigh about 5 000 lb. less than those in Table 1, and the cars of the Long Island Railroad and the Hudson and Manhattan Railroad weigh about 5 000 lb. more. Trains at present are made up of at least one trailer to two motor cars, but, in future, may be composed of motor cars exclusively.

Although a long-span bridge might be loaded with a continuous line of trains on all tracks, it seems hardly possible that they could all be loaded to the maximum at the same time, and the occurrence would be so rare that a load of 2 000 lb. per lin. ft. on all tracks, for spans of 1 000 ft. or more, would cover all contingencies. The local concentration of 27 300 lb. may readily be increased by a change of motor, or by an increased length of car, and should be assumed at 30 000 lb. each. All loads should be augmented by the formula for static equivalent.

For trolley cars, the weights are as follows:

Four-wheeled car, 34 ft. 0 in. long, 29 000 lb. on one truck with 4 ft. 6-in. wheel base	853 lb. per lin. ft.
Eight-wheeled car, 47 ft. 0 in. long, 60 000 lb., equally distributed on two trucks, 20 ft. 0 in. from center to center; wheel base of truck 4 ft. 0 in.	1 277 " " " "
Ash car, 38 ft. 0 in. long, 100 000 lb., equally distributed on two trucks, 23 ft. 6 in. from center to center; wheel base of truck 6 ft. 6 in.	2 632 " " " "

The weight of the ash car is unusual, and should be provided for only incidentally. The weight of the eight-wheeled passenger car is rather less than is sometimes found. It would seem advisable, in order to provide for some increase, to adopt for long-span bridges a uniform load of 1 500 lb. per lin. ft. of track, and also make provision for a single ash car—the loads for short spans to be properly augmented by formula.

The loads on the roadway of a bridge will differ materially from those which are likely to occur above a subway. A driver with an unusually heavy load will not cross a bridge without careful inquiry as to its strength. On the other hand, any load which is hauled through the streets may, unknowingly, be hauled over a subway. For the former, therefore, a reasonable load may be permitted, and the bridge may be protected against excessive weights, while, for the latter, all loads which may occur must be considered.

The truck loads which have occurred in New York City have been ascertained as follows:

1. Cables weighing 84 tons are carried equally distributed on four wheels, the axles 12 ft. 0 in. from center to center, with a wheel gauge of 8 ft. 0 in. The weight of the truck will add 6 tons, and 16 horses, at 1 500 lb. each, will weigh 12 tons more. The length of the truck is 16 ft. and that of eight teams of horses will be 96 ft., making a total of 112 ft.

2. Girders weighing 65 tons are carried mainly on two rear wheels of a long truck. The weight of the truck will add 2 tons for each pair of wheels; the gauge is 8 ft. 0 in. The length of the truck is 40 ft. and that of five teams of horses is 60 ft., making a total of 100 ft.

3. An automobile truck will carry 10 tons on four wheels. The weight of the truck will be 6 tons additional. The axles are 16 ft. apart, and the length of the body is 20 ft. This load averages 1 600 lb. per lin. ft.

4. The R. H. Howe Company has carried 75 tons on a truck weighing 10 tons, most of the load being on the two rear wheels. This load is hauled by 16 horses.

5. A coal truck weighing 2½ tons will carry a load of 7 tons, and will be hauled by three horses weighing 2½ tons more. The length of the truck is 12 ft., the gauge being 8 ft. This load averages 1 000 lb. per lin. ft.

6. An asphalt truck has about the same dimensions and weight as a coal truck.

7. The trucks which carry the Lidgerwood hoists, take a load of 15 tons. The weight of the truck is 3 tons, and that of four horses is 3 tons more. The length of the truck is 15 ft., and that of two teams of horses may be taken at 24 ft.

8. The standard truck for general use carries a load of 5 tons, weighs 2½ tons, and is hauled by two horses weighing 1½ tons more. The length of the truck and pole is 24 ft., and the weight averages 750 lb. per lin. ft.

These loads are summarized in Table 2.

TABLE 2.—WEIGHTS OF TRUCKS.

Kind of truck.	Total load, in tons.	Load, in pounds per linear foot.	Load, in pounds per square foot.
Cable truck	102	1 800	150
Automobile truck	16	1 600	135
Girders on truck	76	1 500	125
Lidgerwood truck	21	1 150	95
Coal truck	12	1 000	85
Asphalt truck	12	1 000	85
Standard truck	9	750	65

Those of the loads in Table 2 which exceed 85 lb. per sq. ft. are for special trucks, and rarely occur. On a long span, probably half the trucks would be empty. The majority would be "standard" or light delivery wagons; yet, in the case of a large conflagration in the city, the span might be packed with people. It would thus seem that 80 lb. per sq. ft. would be a maximum load, if indeed it should not be much less, for long spans.

The Board of Engineers for Manhattan Bridge recommended for local concentrations, 24 tons on two axles spaced 12 ft. apart, with a 5-ft. gauge, and assumed to occupy a width of 12 ft. and a length of 30 ft. A concentration of 15 tons on one axle, with an 8-ft. gauge, may be taken as an equivalent, and more general in its application, as loads are rarely distributed equally on four wheels, but, as shown in Table 2, are more often carried on one axle. The local concentrations of cable trucks, and of heavy girder trucks, are so excessive and so unusual that the loads should be floated on barges to a point sufficiently near the place of delivery, in order to avoid crossing bridges.

Street and sidewalk surfaces, in addition to the loads above mentioned, may support a pile of paving blocks or heavy merchandise. This is usually estimated at from 500 to 1 000 lb. per sq. ft. on the roadway; but, as heavy concentrations are already specified for the roadway, and the quiescent load on the footwalk, is, for uniformity of specification, augmented by formula, a provision of 300 lb. per sq. ft. would seem proper. For heavy concentrations, provision is made for distribution over subways by the soil of varying depth.

Centrifugal Force.—The speed of railroad trains on curves on bridges is usually estimated at 40 miles per hour, or 60 ft. per sec. The probability of this speed obtaining on all tracks at the same time, is very remote.

The formula for centrifugal force is:

$$C = \frac{V^2}{32.2\,R}\,W$$

Where,

C = the centrifugal force;
V = the velocity, in feet per second;
R = the radius of the curve, in feet;
and W = the weight of the train.

For 1° of curvature this formula becomes:

For 40 miles per hour (60 ft. per sec.) ... $C = 0.0195\ W$
" 30 " " " 45 " " " ... $C = 0.011\ W$
" 20 " " " 30 " " " ... $C = 0.0049\ W$
" 10 " " " 15 " " " ... $C = 0.0012\ W$

For curves of less radius than 5 729 ft. (1°) the centrifugal force will vary inversely as the radius, or approximately in direct ratio with the degree of curvature.

Wind Pressure.—The velocity and pressure of the wind on bridges has been a subject of considerable investigation, but of very unsatisfactory determination. Records of severe storms have shown pressures varying from 40 to 80 lb. or more per sq. ft., but it is generally conceded that these great pressures are of short duration and of small area. For a long time, the Tay Bridge was a nightmare to bridge engineers, but it seems to have been well established that it was destroyed, not by excessive wind pressure, but by accident, or possibly by defect in construction. The wind pressure at the time appears to have been considerably less than 30 lb. per sq. ft. The late C. Shaler Smith, M. Am. Soc. C. E., found only one case where a pressure of 30 lb. per sq. ft. exceeded 60 ft. in width, and, in the case of a 320-ft. span, designed by him for 30 lb. per sq. ft., with 20 000 lb. per sq. in. allowable strain on wrought iron, a tornado showing a pressure of 52 lb. per sq. ft. on the bridge, and 84 lb. pressure elsewhere, did not destroy the span. At Stamford, Conn., in 1904, the writer witnessed a tornado which uprooted trees and swept a clean path, about 100 ft. wide, across the city, but was hardly felt elsewhere. The provision of 30 lb. per sq. ft., therefore, would seem to make ample provision for safety.

Sliding Friction.—The coefficient of sliding friction for tractive power may be assumed as 20% or more, but emergency-brake tests on especially equipped trains show from 12 to 16%, and even this would probably never occur on all trains at the same time on a long-span bridge fully loaded. Considering the improbability of its occurrence, and the fact that the allowable strain is well within the yield point, a coefficient of 10% would seem to make ample provision.

Reinforced Concrete.—The specifications covering the design of reinforced concrete are a concise abstract of what may be considered general practice. Preference has been given to deformed bars as a factor of safety.

The writer is indebted to A. J. Malukoff, Assoc. M. Am. Soc. C. E., Assistant Engineer, Department of Bridges, New York City, for his thorough work in compiling tests and other information, and to Mr. A. I. Raisman, Assistant Engineer, Public Service Commission, for his deduction of the formula for the permissible pressure on piles.

With this general, though brief, review of the specifications, they are presented to the Society for such use or discussion as may be desired. They have been in regular service about 3 years, and little modification has been suggested.

SPECIFICATIONS
FOR THE DESIGN OF BRIDGES AND SUBWAYS.

LOADS.

The structure shall be designed to resist the strains* due to the following loads:

Dead Load.—The dead load shall consist of the entire weight of the structure. In the case of subways, it shall include the weight of the superimposed earth and, when under private property, such loads as are provided for by the Building Law.

The strains computed therefrom will be considered as static.

The weight of the materials shall be estimated as follows:

Material.	Weight, per cubic foot.
Steel, rolled and cast	490 lb.
Iron, wrought	480 "
Iron, cast	450 "
Earth	100 "
Timber, untreated	48 "
Timber, treated	60 "
Masonry (average)	150 "
Buildings, per floor. See Building Law.	

Live Load.—The live load shall consist of the moving load plus the increase by formula for equivalent static strain given herein. The resulting strains shall be considered in effect as equivalent to a static strain of like amount.

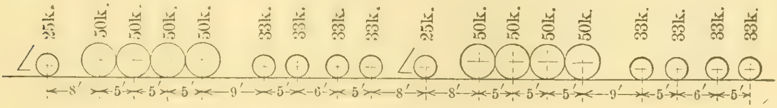

FIG. 1.

Moving Load (1 k. = 1 000 lb.).—The moving loads shall be assumed as follows:

Railroad trains on bridges shall be estimated as a continuous train of 5 000 lb. (5 k.) per lin. ft. of each track headed by two typical engines with wheel loads as shown by Fig. 1.

Elevated or subway trains shall be estimated as continuous at 2 000 lb. (2 k.) per lin. ft. of each track, or as a local concentration of two adjacent motor trucks with axle loads spaced as shown by Fig. 2.

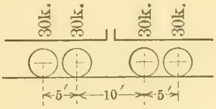

FIG. 2.

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* The term "strain" is here used for a force, and the term "deformation" for change of dimension.

Trolley cars shall be estimated as continuous at 1 500 lb. ($1\frac{1}{2}$ k.) per lin. ft. of each track, or as a local concentration of one ash car with axle loads spaced as shown by Fig. 3.

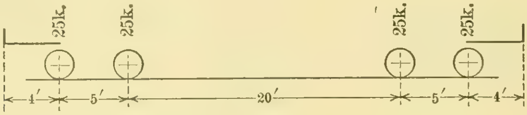

FIG. 3.

On subways, provision shall be made for a continuous line of ash cars.

The roadbed for trolley cars on bridges shall be assumed as 12 ft. wide, and shall be capable of carrying the loads specified for the roadways of bridges.

The roadway load for bridges shall consist of a uniform load of 80 lb. per sq. ft. of surface, or a local concentration of 30 k. on one axle, with a wheel gauge of 8 ft. This load may be assumed to cover a space 12 ft. wide and 40 ft. long.

On subways it shall consist of a uniform load of 300 lb. per sq. ft. of surface, or a local concentration of 100 k. on four wheels, 12 ft. between axles, and 8 ft. gauge.

Footwalks for bridges and in subways shall be estimated as loaded at 80 lb. per sq. ft. of surface. Sidewalks over subways shall be estimated at 300 lb. per sq. ft. of surface.

When concentrated loads are carried on subways they may be assumed to be distributed over an area 2 ft. square on the pavement and thence through the earth at a slope of $\frac{1}{2}:1$.

The centrifugal force shall be estimated by the following formula:

$$C = 0.020\ W\ D;^*$$

Where,

C = Centrifugal force,
W = Weight of moving cars,
D = Degree of curvature.

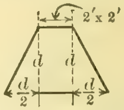

FIG. 4.

All the moving loads above specified shall be increased according to their various lengths by the following formula to produce the static equivalent:

$$S = 125 - \frac{1}{8}\sqrt{2\,000\,L - L^2}$$

$$(S = 0, \text{ when } L > 1\,000 \text{ ft.})$$

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* Reduce this coefficient by 0.001 per degree of curvature from $D = 3°$ to $D = 20°$. For sharper curves use the coefficient for a 20° curve.

Where,

S = Increase, in percentage;

L = Length, in feet, of applied loading which produces maximum strain in the member. Not to exceed 1 000 ft.

Provision shall be made for a wind pressure, acting in either direction, horizontally, of 30 lb. per sq. ft., of the surface as seen in elevation, of the floor system, considering ties, etc., as solid area, of one truss complete, and of one-half the surface of all remaining trusses, as well as that of a train 14 ft. high and 500 ft. (or less) in length. The pressure on the train, as well as one-half the pressure on the structure shall be considered as moving load.

Provision shall be made for the sudden starting or stopping of a train 500 ft. in length, estimating the coefficient of sliding friction at 10 per cent.

There will be no increase by formula for static equivalent to either the longitudinal or wind forces.

On bridges, provision shall be made for a variation in temperature of 120° Fahr. (A difference of 40° in the temperature of the chords of the same truss, or in that of adjacent trusses of the same structure shall be considered in spans of more than 300 ft.)

In calculating the shearing strains on bridges, from uniform moving loads, the panel lengths shall be considered as fully covered, but the half-panel load at the head shall be neglected.

ALLOWABLE STATIC STRAINS.

The static strains from dead load and the equivalent static strains from moving load shall be combined, and the maximum strains in either direction deduced therefrom.

Members subject to alternate strains of tension and compression shall be proportioned for the strain giving the largest section, and designed to resist each strain. If the alternate strains occur in immediate succession (as when produced by moving load), each strain shall be increased by 50% of the smaller. The connections, in either case, shall be proportioned for the arithmetical sum of the strains.

The allowable static strain per square inch for the total combined loading shall in no case exceed those given in the following tables.

In all cases, however, where the structure takes any building load, the design shall be made in accordance with the Building Law.

When beams and girders are embedded in concrete, the allowable flange strain may be increased 25 per cent.

In case of field rivets, 25% excess will be added to the number of rivets required as above. (When machine-driven, this may be reduced to 15% excess.)

ALLOWABLE STATIC STRAINS FOR STEEL, IRON, AND REINFORCED CONCRETE.

In units of 1 000 lb. = 1 k. per sq. in.

All live strains must first be increased to equivalent static strains by formula.

Nature of strain.	Steel wire.	Nickel.	STEEL.		IRON.		Concrete, reinforced.
			Medium structural.	Cast.	Wrought.	Cast.	
Tension. (Net)	75 k.	30 k.	20 k.	16 k.	16 k.	4 k.	0.07 k.
Compression. (1 diam.) (Gross)	....	30 k.	20 k.	20 k.	16 k.	20 k.	....
Compression. (8 diams.) "	....	....	....	....	....	....	0.50 k.
Compression. (12 diams.) "	....	24.7 k.	16.5 k.	....	13.2 k.	....	....
Compression. Columns*	....	$\dfrac{30\text{ k.}}{1+\dfrac{l^2}{8\,000\,r^2}}$	$\dfrac{20\text{ k.*}}{1+\dfrac{l^2}{8\,000\,r^2}}$	....	$\dfrac{16\text{ k.*}}{1+\dfrac{l^2}{8\,000\,r^2}}$	$\dfrac{20\text{ k.*}}{1+\dfrac{l^2}{1\,000\,r^2}}$	$\dfrac{0.550\text{ k.*}}{1+\dfrac{l^2}{600\,t^2}}$
Bending. (Beams, outer fiber)	....	30 k.	20 k.	....	16 k.	....	0.60 k.
Bending. (Pins, rivets, and bolts)	....	45 k.	30 k.	....	24 k.	....	....
Shear. (Pins, rivets, web) (net section)	....	22 k.	15 k.	16 k.	12 k.	4 k.	0.07 k.
Bearing. (Pins, rivets, and bolts)	....	45 k.	30 k.	....	24 k.	....	....
Bearing. (Roller.) Per linear inch	....	1.0 k. d	0.75 k. d	....	0.5 k. d	....	....
Adhesion. Concrete to steel. (Deformed bars)	....	....	....	....	....	....	0.10 k.

* Compression members in steel and iron shall not receive greater unit strain than that allowed for 12 diameters, and in reinforced concrete not greater than that allowed for 8 diameters.

l = Length of column, in inches;

r = Least radius of gyration of cross-section, in inches;

d = Diameter of roller, in inches;

t = Least thickness, in inches.

When tension on rivets is unavoidable, the tensile component shall be considered as having double the effect of an equal amount of true shear.

In designing the invert, the live load on top of the subway may be neglected where the loads on columns and walls are distributed over the whole invert.

Allowable Static Strains for Timber.

In units of 1 000 lb. = 1 k. per sq. in.

All live strains must first be increased to equivalent static strains by formula.

Nature of strain.	White oak.	White pine.	Georgia pine.	Spruce.	Hemlock.
Tension, with grain	1.5 k.	1.0 k.	1.8 k.	1.2 k.	0.9 k.
Tension, across grain	0.3 k.	0.075 k.	0.09 k.	0.075 k.	
Compression, end bearing	2.1 k.	1.6 k.	2.4 k.	1.8 k.	
Compression, to 15 diameters	1.3 k.	1.0 k.	1.5 k.	1.2 k.	1.2 k.
Compression, columns*	$\frac{1.6\text{ k. *}}{1+\frac{l^2}{1\,000\,d^2}}$	$\frac{1.2\text{ k. *}}{1+\frac{l^2}{1\,000\,d^2}}$	$\frac{1.8\text{ k. *}}{1+\frac{l^2}{1\,000\,d^2}}$	$\frac{1.4\text{ k. *}}{1+\frac{l^2}{1\,000\,d^2}}$	$\frac{1.4\text{ k. *}}{1+\frac{l^2}{1\,000\,d^2}}$
Compression, across grain	0.75 k.	0.3 k.	0.5 k.	0.3 k.	0.2 k.
Shear, across grain	1.5 k.	0.75 k.	1.9 k.	1.1 k.	0.9 k.
Shear, with grain	0.3 k.	0.15 k.	0.2 k.	0.15 k.	0.15 k.
Bending, outer fiber	1.5 k.	1.0 k.	1.8 k.	1.0 k.	0.9 k.
Modulus of elasticity	1 100 k.	1 000 k.	1 700 k.	1 200 k.	900 k.

* Compression members of timber shall not receive greater unit strain than that allowed for 15 diameters. When designed to take shear with the grain, selected timber shall be used.

l = Length of column, in inches ;

d = Least diameter of column, in inches.

In this table the values for allowable static strains for timber are 50% greater than those formerly used for miscellaneous loading, and 100% greater than would be allowed for a moving load suddenly applied.

Allowable Static Pressures.

The following allowable pressures are for static loads only. All live loads shall first be increased to equivalent static loads by formula.

Allowable Static Pressures on Masonry.

Granite (cut stone)	80 k. per sq. ft.
Limestone (cut stone)	60 k. " " "
Sandstone (cut stone)	40 k. " " "
Rubble	30 k. " " "
Concrete (1:3:6)	50 k. " " "
Concrete (1:2:4)	60 k. " " "
Brickwork, Portland cement	40 k. " " "

For a wall of height, h, exceeding eight times its thickness, t, the above pressures, P, should be reduced by the following formula:

$$p = \frac{P\,(1.1)}{1+\frac{h^2}{600\,t^2}}.$$

ALLOWABLE STATIC PRESSURES ON SOILS.

Sound ledge rock	150 k. per sq. ft.
Hardpan, or compact gravel	20 k. " " "
Coarse sand, or gravel	12 k. " " "
Clean sand, or dry clay	8 k. " " "
Clay, moist	4 k. " " "
Silt	2 k. " " "

The above allowable static pressures are for the most favorable conditions. For questionable soils these pressures should be reduced 50 per cent. In deep foundations, friction and buoyancy may be allowed for in computation.

Piles—Designed for 40 k. Each (Static).—The actual sustaining value, in equivalent static load, shall be ascertained in the field as follows:

1st.—When a pile is driven to refusal, and supports by end bearing, without side friction, allow 1 400 lb. per sq. in. of net section, properly reduced for column length when not stayed.

2d.—When driven to resistance by hammer blows: $p = \frac{3\,W h}{d + 1}$.

3d.—When driven by water-jet, or by hammer, in soft material:

$$p = (S\,a + R)\,l.$$

p = Safe static load per pile, in pounds;
W = Weight of hammer, in pounds;
h = Height of fall of last blow, in feet;
d = Penetration under last blow, in inches;
S = Skin surface of pile under soil, in square feet;
l = Length of pile in ground, in feet.

$S\,a\,l$, represents the resistance due to skin friction.

$R\,l$, represents the value of end bearing for a diameter of 12 in. at the point of the pile.

For loam and silt	$a = 1.7$	$R = 47$
" moist clay	$a = 7.4$	$R = 96$
" sand, or clay	$a = 19.2$	$R = 203$
" coarse sand and gravel	$a = 29.0$	$R = 300$

DETAILS OF DESIGN,

FOR STRUCTURAL STEEL AND IRON.

Spans for Calculation.—The assumed spans for calculation shall be as follows:

Pin-connected trusses	distance between centers of end pins.
Riveted girders	distance between centers of bearings.
Cross-girders	distance between centers of trusses or columns.
Stringers	distance between centers of cross-girders.
Cross-ties and flooring	distance between centers of stringers.

Depth for Calculation.—The assumed depth for calculation shall be:

Pin-connected trusses..distance between centers of chord pins.
Riveted-lattice trusses.distance between centers of gravity of chords.
Plate-girders ....distance between centers of gravity of flanges.
(Not to exceed out to out of flange angles.)

Lateral Bracing.—Each main panel of deck bridges shall be provided with intermediate sway-bracing of a sufficient section to carry one-half the maximum increment due to wind on train, and to centrifugal force. The end sway-bracing shall be proportioned to carry the lateral strain to the support.

Through bridges shall be provided with post-brackets, at the intermediate panel points, of sufficient strength to maintain the panel in a vertical position under the specified wind pressure; or, when the height of the top chord exceeds 20 ft. above the floor, an overhead system of sway-bracing shall be used.

Rigid lateral bracing will be preferred.

The value of $\frac{l}{r}$ for rigid members shall not exceed 200.

Where adjustable rods are used, check-nuts will be provided, and the rod shall be designed to receive an initial strain of 10 k.

Design of Details.—The use of rolled material which exceeds $\frac{5}{8}$ in. in thickness, and is to be punched, shall be generally avoided.

All parts shall preferably be designed so that the strains coming on them may be calculated definitely.

The center line of resistance of a member will be along its neutral axis, and connections shall be designed so as to avoid bending the member or its details.

The line of strain shall pass centrally through any cluster of rivets which resist it, and where angles or plates are connected in any other manner, proper provision shall be made for the moments and secondary strains produced.

Details shall be designed so as to give free access for inspection and painting, and water-pockets shall be avoided.

In no case shall the details be of less strength than the member as designed.

All members which are subject to direct strains combined with bending shall be proportioned so that the greatest fiber strain will not exceed the specified allowable strain, properly reduced in the case of columns.

In continuous upper chords of deck bridges carrying the floor, the bending strain due to the live load shall be computed from a moment equal to three-quarters of the maximum moment produced on a span of one panel considered as a simple beam.

The strain on the outer fiber of solid shapes shall be computed from the moment of inertia of the section.

Plate Girders.—When the web-plate is not spliced, one-eighth of its gross section may be considered as flange area.

No allowance shall be made for the web, when spliced, in calculating the flange section of plate girders.

At least one upper flange plate, when used (except when embedded in concrete), shall extend from end to end of the girder. Any additional plates used to make up the flange section shall be of such lengths as to allow at least two rows of rivets of the regular pitch being placed at each end of the plate beyond the theoretical point required, and there shall be a sufficient number of rivets at the ends of the plate to transmit their value before the theoretical point of the next outside plate is reached.

Where the flange plates vary in thickness, they shall decrease outward from the flange angles.

The total thickness of plates and angles shall not exceed five times the diameter of the rivets used.

All flange plates, subject to either tension or compression, spliced in the length of the girder, shall be properly covered with an extra amount of material equal in section to the material spliced, with sufficient rivets on either side to transmit the strains from the parts cut.

The upper flanges shall be braced at intervals not exceeding sixteen times the width. Where this is impracticable, the allowable compressive flange strain shall be reduced in accordance with the following formula:

$$p = \frac{P}{1 + \frac{L^2}{1\,200\ W^2}}$$

Where,

p = The reduced strain per square inch allowable;
L = The unbraced length of flange, in inches;
W = The width of flange, in inches.

Values of P = 20 k. for medium steel and 16 k. for wrought iron.

In calculating the shearing or bearing strain in web rivets of plate girders, the whole of the shear acting on the side of the panel nearest the abutment shall be considered as being transferred into the flange angles within a distance equal to the depth of the girder.

The webs of plate girders, wherever cut, shall be spliced by a plate on each side of the web capable of transmitting the full shearing strain through splice rivets.

When the thickness of the web is less than one-fiftieth of the unsupported distance between flange angles, stiffeners shall be riveted on both sides of the web, with the outstanding leg as long as the flange angles will allow. The distance from center to center of stiffeners, generally, shall not exceed the depth of the full web-plate, but they shall in no case be closer than 4 ft., nor farther apart than 6 ft. Web-plates, generally, shall have stiffeners at all splices, at points of concentrated loading, and at each end of bearing plates.

Net Sections.—Net sections shall be used in all cases in calculating tension members, and, in deducting rivet holes, they shall be taken as $\frac{1}{8}$ in. wider than the nominal diameter of the rivet.

In calculating the net sections having rivets staggered, all rows shall be deducted unless arranged so that the net section along a zigzag line, taking all distances in a diagonal direction at only three-fourths of their value, exceeds the corresponding net section across the plate.

Pin-connected, riveted, tension members shall have a net section back of the pin-hole, parallel to the axis of the member, of not less than the required net section of the body of the member, and shall have a section through the pin-hole at least 25% in excess of that required section.

Rivet Spacing.—Rivets shall not be spaced closer than three diameters from center to center, nor farther apart in the direction of the strain than sixteen times the thickness of the thinnest external plate connected, and not more than thirty-two times that thickness, at right angles to the line of strain.

Rivets shall not be spaced closer to the sides of plates than $1\frac{1}{4}$ diameters to the center of the rivet, nor farther from the side than eight times the thickness of the plate. In no case shall the pitch of rivets exceed 6 in.

Field rivets shall be reduced to a minimum.

Built chords, when faced for bearings, shall be spliced on four sides sufficiently to hold the abutting members accurately in place and to transmit 50% of the strain through the splice-plates. All other joints shall be fully spliced.

Where strain is to be transmitted through idle material, the latter shall be extended for direct riveting.

When necessary to obtain sufficient bearing surface at pin-holes, reinforcing plates shall be added. These plates shall be designed to distribute their proportion of the bearing strain from the pins to the member to which they are connected.

Latticing Compression Members.—All segments of members in compression, connected by latticing only, shall have batten-plates at each end, the thickness of which shall be not less than one-fortieth of the distance between the rivets connecting them to the compression member. In no case shall the length of the batten-plates be less than $1\frac{1}{4}$ times the width of the member.

The pitch of rivets at the ends of built compression members shall not exceed 4 diameters for a distance 1¼ times the width of the member.

The distance between the connections of latticing shall be such that the individual members between them, composing the column, shall be stronger than the column as a whole, and in no case shall this distance exceed 8 times the least width of these members. Where the ends of the compression member are forked to connect with pins, the combined strength of these legs shall be, at least, twice the strength of the column, and the reinforcing plates shall extend not less than 6 in. beyond the edge of the batten-plates. As much of the column flange as is practicable shall extend the full length of the reinforcing plates.

Single lattice bars shall generally be inclined at an angle of 60° to the axis of the member and double lattice bars at an angle of 45°, with a rivet at their intersection.

Single lattice bars shall have a thickness of not less than one-fortieth, and double lattice bars not less than one-fiftieth, of the distance between the rivets connecting them to the compression member, and their width shall be:

For	33-in.	to 48-in.	web,	6-in.	flange	angles,	four	⅞-in.	rivets,	use	6 by 3½ by ½-in. angles.
“	20 “	“ 32 “	“	4 “	“	“	two	⅞ “	“	“	5½-in. strap.
“	15 “	“ 19 “	“	4 “	“	“	one	⅞ “	rivet,	“	3½ “ “
“	12 “	channels or		3 “	“	“	one	¾ “	“	“	3 “ “
“	9 “	“	“	2½-in.	“	“	one	¾ “	“	“	2½ “ “
“	8 “	“	“	2	“ “	“	one	⅝ “	“	“	2 “ “

Expansion Rollers.—All bridges more than 80 ft. long, which bear on masonry, shall be provided with pin-bearing bolsters, and at one end with turned friction rollers not less than 4 in. in diameter between two planed surfaces.

For spans of 80 ft. or less, planed surfaces shall be used without rollers.

The nest of rollers shall be designed so as to prevent displacement, and be kept dust free.

Bearings Anchored.—Trusses shall be secured against side motion on bearing plates and rollers.

The bolster blocks shall be joined to the truss, and the bearing plates shall be secured to the underlying supports by bolts or dowels.

Eye-Bar Packing.—Eye-bars shall be packed so as to produce the least bending moment on the pin, and shall not be packed out of line with the axis of the member more than ⅛ in. to 1 ft.

Members packed on pins shall be held against lateral movement by filling rings. The pin shall be of sufficient length to give full bearing to all members and with screw ends extending two threads beyond the nut, to permit burring.

Minimum Section.—No material less than ⅜ in. thick shall be used, except for packing or other idle purposes. Counter-rods shall have not less than 1½ sq. in. in sectional area.

Camber.—Truss bridges shall be given a camber by making the compression chord longer than the tension chord, in the proportion of ⅛ in. to 10 ft.

DETAILS OF DESIGN FOR REINFORCED CONCRETE.

General Rules for Design.

Spans for Calculation.—The length of span, for calculation, shall be the distance, in the clear, plus the width required for the theoretical bearing.

Design of Details.—The covering for the reinforcing metal in beams shall be not less than 1 in. of concrete, and in floor slabs and other thin structures it shall be not less than ½ in. In all other cases it shall be not less than 1½ in., and in no case shall it be less than 1¼ times the diameter of the bar used.

Reinforcing bars shall be spaced not farther apart than 6 times the thickness of the bar (except in T-beam construction), and arranged so as to permit spading readily. Deformed bars shall generally be used, but, where plain bars are permitted, the allowable adhesive strain shall be reduced 30%, and the bars shall be spaced not closer than 4 diameters.

Shear.—The concrete between the centers of flange strain shall be sufficient to take up the maximum shear; otherwise, straps, properly spaced, shall be supplied to make up the deficiency.

Straps, when needed, shall generally have a spacing equal to one-half to once the depth between the centers of strains, and shall be designed to take up in tension that part of the increment of the longitudinal strain which is not taken up by the concrete.

The straps shall be wrapped around the longitudinal reinforcement, and shall be designed to transfer their strains to the flanges.

The ends of alternate longitudinal reinforcement bars shall preferably be bent to make an angle of 30° with the flange, and extend to the compression flange above the support.

The strains shall be calculated in accordance with the following rules and formulas:

Proportion for mixing concrete................1:2:4
Maximum tension in steel.....................$F_s = 20$ k.
Maximum compression in concrete, of beams....$F_c =$ 0.6 k. per sq. in.
Maximum compression in concrete, of columns..$F_c =$ 0.5 k. " " "

except that when the height of the column exceeds 8 times the least dimension, this value is to be reduced by the formula:

$$p = \frac{0.550\text{ k.}}{1 + \dfrac{L^2}{600\,t^2}}$$

Where,

p = Maximum compression per square inch;
L = Length, in inches;
t = Least thickness, in inches.

Steel bars in compression members, up to 2% of the cross-section of the member, may be considered to take a strain per unit equal to 15 times that permitted in the concrete. Such reinforcing bars must be properly laced at distances not greater than the least dimension of the member.

Maximum shear in concrete............	0.07 k. per sq. in.
Maximum adhesion of concrete to steel (deformed bars)....................	0.10 k. " " "
Modulus of elasticity of steel...........	30 000 000
Modulus of elasticity of concrete........	2 000 000

Bending.—To design for bending, the following assumptions will be made:

1st.—The bending strain in any fiber varies directly as the distance from the neutral axis.

2d.—The ratio between the moduli of elasticity of steel and of concrete is constant for the working strains assumed:

$$\frac{E_s}{E_c} = 15.$$

3d.—The longitudinal tensile strain of concrete, generally, shall not be considered.

4th.—Beams and slabs shall be calculated as simply supported, but rods shall be placed in compression flanges over supports, to prevent cracking.

Formulas for Calculations.—

Let M = the maximum bending moment in the beam.

$$p' = \frac{A_s}{b\,d} = \frac{\text{Area of steel}}{\text{Effective area of beam}}.$$

$$e = \frac{E_s}{E_c}.$$

$$A_c = \text{Area of concrete.}$$

Bending.

Location of Neutral Axis.—The neutral axis passes through the center of gravity of the effective section, if the concrete below the neutral axis is disregarded and the area of the steel is assumed equal to *e* times its area of concrete; accordingly:

$$b\,x\,d\,\frac{x\,d}{2} = e\,A_s\,(d - x\,d);$$

$$\text{but } A_s = p'\,b\,d\,;$$

$$\text{therefore, } b\,d^2\,\frac{x^2}{2} = e\,p'\,b\,d^2\,(1 - x);$$

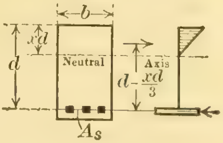


FIG. 5.

dividing both sides by $b\,d^2$, we obtain:

$$\frac{x^2}{2} = e\,p'\,(1 - x);$$

$$\text{whence } x = \pm\sqrt{2\,e\,p'\left(1 + \frac{e\,p'}{2}\right)} - e\,p'.$$

Note here that x depends only on e and p', and is independent of b and d. It can readily be tabulated. (See table on page 1286.)

Resisting Moment of Rectangular Beams.—Having the location of the neutral axis, the resisting moment follows directly:

$$M = \frac{1}{2} f_c\,b\,x\,d\left(d - \frac{x\,d}{3}\right) = \frac{1}{2} f_c\,x\left(1 - \frac{x}{3}\right)b\,d^2 = k_c\,b\,d^2, \text{ and}$$

$$M = f_s\,A_s\left(d - \frac{x\,d}{3}\right) = f_s\left(1 - \frac{x}{3}\right)p'\,b\,d^2 = k_s\,b\,d^2,$$

$$\text{where } k_c = \frac{1}{2} f_c\,x\left(1 - \frac{x}{3}\right), \text{ and } k_s = p'\,f_s\left(1 - \frac{x}{3}\right).$$

The values of k_c and k_s depend only on the proportion of steel for any given value of e. Tables are given herewith for these values. Use the smaller k for the design of beams. From 0.70 to 1.50% of steel gives the usual economical sections.

Resisting Moment of **T**-*Beams.*—As the concrete below the neutral axis is not considered for the resisting moment of a beam, the formula for resisting moment of a **T**-section is the same as for an ordinary beam, providing the neutral axis passes through the flange.

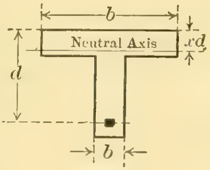


FIG. 6.

Where the neutral axis passes through the stem, a general formula is too cumbersome for use. The location of the neutral axis may be calculated as indicated above.

Shear.

$$\text{Unit shear} = \frac{\text{max. shear}}{b\,d\left(1 - \frac{x}{3}\right)} \text{ for plain reinforced beams.}$$

$$\text{`` \quad ``} = \frac{\text{max. shear}}{b'd\left(1 - \frac{x}{3}\right)} \text{ for } \mathbf{T}\text{-beams.}$$

Adhesion.—

$$\text{Unit adhesion} = \frac{\text{maximum shear}}{d\left(1 - \frac{x}{3}\right)\text{ perimeter of rod sections}}.$$

Columns.—

Maximum column load $= p\,(A_c + e\,A_s)$.

$$\text{Where, } p = \frac{550}{1 + \frac{l^2}{600\ t^2}}$$

l being the length, and
t the least dimension, of the column, in inches.

The maximum value of $p = 500$ lb.

TABLE OF VALUES OF x, k_c, k_s, ETC.

For $f_s = 20\ 000$ lb., $f_c = 600$ lb., $\frac{E_s}{E_c} = 15$, Max. shear $= 70$ lb.,
Max. adhesion $= 100$ lb.

p'	x	k_c	k_s	Maximum load per square foot on account of shear, in pounds.	MINIMUM SPAN FOR RODS.			
					¾-in.	1-in.	1¼-in.	1½-in.
0.002	0.218	61	37	8 200	10 ft.	13 ft.	16 ft.	20 ft.
0.003	0.258	71	55	5 370	10 “	13 “	16 “	20 “
0.004	0.292	79	72	4 000	10 “	13 “	16 “	20 “
0.005	0.320	86	90	3 270	12 “	16 “	20 “	24 “
0.006	0.344	91	106	3 040	10 “	14 “	18 “	21 “
0.007	0.365	96	122	2 840	10 “	13 “	16 “	20 “
0.008	0.384	101	140	2 700	9 “	12 “	15 “	18 “
0.009	0.402	104	156	2 550	8 “	11 “	14 “	17 “
0.010	0.418	108	172	2 420	8 “	10 “	13 “	16 “
0.011	0.433	112	189	2 310	7 “	10 “	12 “	15 “
0.012	0.446	114	204	2 240	7 “	9 “	12 “	14 “
0.013	0.460	116	220	2 180	7 “	9 “	11 “	13 “
0.014	0.471	119	236	2 090	6 “	8 “	10 “	13 “
0.015	0.484	121	252	2 060	6 “	8 “	10 “	12 “
0.016	0.491	123	267	2 000	6 “	8 “	10 “	12 “
0.017	0.503	126	284	1 940	6 “	7 “	9 “	11 “
0.018	0.513	127	299	1 890	5 “	7 “	9 “	11 “
0.019	0.523	129	314	1 860	5 “	7 “	9 “	10 “
0.020	0.530	131	330	1 820	5 “	7 “	8 “	10 “
0.021	0.539	133	345	1 790	5 “	7 “	8 “	10 “
0.022	0.542	134	360	1 760	5 “	6 “	8 “	9 “
0.023	0.555	135	375	1 730	5 “	6 “	8 “	9 “
0.024	0.562	137	390	1 700	4 “	6 “	7 “	9 “
0.025	0.569	138	405	1 680	4 “	6 “	7 “	9 “
0.026	0.575	139	420	1 660	4 “	6 “	7 “	8 “
0.027	0.580	140	436	1 640	4 “	5 “	7 “	8 “
0.028	0.588	142	450	1 620	4 “	5 “	7 “	8 “
0.029	0.595	143	465	1 590	4 “	5 “	6 “	8 “
0.030	0.600	144	477	1 570	4 “	5 “	6 “	8 “

“ Minimum Span for Rods ” gives the smallest spans where given rods may be used for uniform load on account of adhesion to rods.

“Maximum load per square foot” gives the maximum load that may be used for uniformly-loaded beams, on account of shear of concrete.

ALLOWABLE COMPRESSIVE STRAINS FOR STEEL, WROUGHT-IRON AND CAST-IRON COLUMNS

The quantities below give the proportion of allowable compressive strain per square inch of cross-section for the different values of l/d, and d^2/r^2, where d = least diameter.

MEDIUM STEEL AND WROUGHT IRON

l/d	d^2/r^2 6	7	8	9	10	12	14	16	18	20	24	28	32	36
12	.903	.888	.874	.860	.847	.822	.799	.776	.755	.735	.699	.665	.633	.606
13	.888	.870	.855	.841	.826	.797	.772	.747	.724	.703	.663	.628	.596	.568
14	.872	.854	.836	.820	.803	.773	.745	.718	.693	.671	.630	.593	.560	.531
15	.856	.835	.816	.797	.781	.748	.717	.690	.663	.640	.597	.559	.526	.497
16	.839	.817	.796	.776	.758	.723	.691	.661	.634	.610	.566	.527	.494	.464
17	.822	.798	.776	.754	.735	.698	.664	.634	.606	.580	.535	.497	.464	.435
18	.804	.779	.755	.732	.712	.673	.638	.607	.578	.552	.507	.468	.435	.407
19	.786	.759	.735	.711	.689	.648	.613	.580	.552	.525	.480	.442	.409	.381
20	.769	.741	.714	.689	.666	.625	.588	.556	.526	.500	.454	.417	.384	.357
21	.751	.721	.694	.668	.644	.602	.564	.531	.502	.475	.430	.393	.362	.335
22	.732	.702	.674	.647	.623	.579	.542	.508	.478	.453	.408	.371	.341	.314
23	.716	.683	.654	.627	.602	.558	.519	.486	.456	.430	.387	.351	.319	.296
24	.698	.665	.634	.607	.581	.536	.498	.464	.436	.410	.367	.332	.303	.278
25	.680	.646	.615	.587	.561	.515	.478	.444	.416	.390	.348	.313	.286	.262
26	.663	.628	.596	.568	.542	.496	.458	.425	.397	.372	.330	.297	.270	.247
27	.646	.610	.578	.549	.523	.477	.439	.404	.379	.354	.314	.282	.255	.234
28	.630	.593	.560	.531	.505	.459	.422	.389	.362	.338	.298	.267	.242	.221
29	.613	.576	.543	.514	.487	.442	.404	.373	.346	.323	.284	.254	.229	.209
30	.596	.558	.526	.496	.469	.424	.387	.356	.330	.307	.269	.240	.216	.197
32	.565	.527	.494	.464	.438	.394	.358	.328	.302	.281	.245	.218	.196	.178
34	.535	.497	.464	.435	.409	.366	.330	.302	.278	.257	.224	.198	.178	.161
36	.507	.468	.435	.407	.382	.339	.306	.278	.255	.236	.204	.180	.162	.146
38	.480	.442	.409	.381	.356	.316	.283	.257	.235	.217	.188	.165	.147	.133
40	.454	.417	.385	.357	.333	.294	.263	.238	.217	.200	.172	.152	.135	.122
42	.430	.393	.362	.335	.312	.274	.245	.221	.201	.185	.157	.140	.124	.112
44	.408	.371	.341	.314	.292	.256	.228	.205	.187	.171	.147	.129	.114	.103
46	.386	.351	.321	.296	.274	.240	.213	.191	.174	.159	.136	.119	.106	.095
48	.367	.331	.303	.278	.258	.224	.199	.178	.162	.148	.126	.110	.098	.088
52	.330	.297	.270	.247	.228	.198	.174	.156	.141	.129	.110	.096	.085	.076
56	.298	.267	.242	.221	.203	.175	.154	.138	.124	.113	.096	.084	.073	.065
60	.270	.241	.217	.198	.182	.156	.137	.122	.110	.100	.084	.074	.065	.058

CAST IRON

l/d	d^2/r^2 6	7	8	9	10	12	14	16
12	.537	.498	.466	.435	.410	.366	.331	.302
13	.498	.458	.426	.397	.372	.330	.297	.269
14	.459	.422	.389	.362	.338	.299	.268	.242
15	.426	.388	.357	.330	.308	.271	.241	.217
16	.394	.358	[illegible]	.303	.281	.246	.218	.196
17	.366	.331	.302	.277	.257	.224	.198	.178
18	.340	.306	.278	.255	.236	.204	.181	.162
19	.316	.283	.257	.235	.217	.187	.165	.148
20	.294	.263	.238	.217	.200	.173	.151	.135
21	.274	.244	.221	.201	.184	.159	.139	.124
22	.257	.228	.205	.187	.171	.147	.129	.114
23	.240	.213	.191	.174	.159	.136	.119	.106
24	.224	.199	.178	.162	.148	.127	.110	.098
25	.211	.186	.167	.151	.138	.118	.103	.091
26	.198	.175	.156	.141	.129	.110	.096	.085
27	.186	.164	.146	.132	.120	.102	.089	.079
28	.175	.154	.138	.124	.113	.096	.084	.074
29	.165	.145	.129	.117	.106	.091	.078	.069
30	.156	.137	.122	.110	.100	.085	.073	.065
32	.140	.123	.109	.098	.089	.075	.065	.057
34	.126	.109	.098	.088	.080	.067	.058	.051
36	.114	.099	.088	.078	.072	.060	.052	.046
38	.103	.090	.080	.072	.065	.055	.047	.041
40	.094	.082	.072	.065	.059	.049	.043	.038

COLUMN FORMULAS

For Steel and Wrought Iron

$$p = \frac{a}{1 + \frac{l^2}{8000\,r^2}}$$

For Cast Iron

$$p = \frac{a}{1 + \frac{l^2}{1000\,r^2}}$$

	AVERAGE VALUES OF d^2/r^2.	FOR LIGHT WEIGHT	FOR HEAVY WEIGHT
∧	Even-legged Angles	26.0	26.4
┌	Uneven " "	10.0	10.0
┍	" " "	11.7	11.7
[	Channels 2 to 12-in.	6.8	6.8
[	" 15-in.	7.4	
⊓	" 2 to 15-in.	12.7	12.7
T	Deck-Beams 4 to 10-in.	7.1	7.1
⊢	" " " " " "	35.0	35.0
I	I-Beams 6 to 15-in.	6.4	6.4
H	" " " " " "	21.6	22.5

	AVERAGE VALUES OF d^2/r^2.	FOR LIGHT WEIGHT	FOR HEAVY WEIGHT
○	Solid Cylinder	16.0	
◎	Hollow " Thick. from 0.01 to 0.02 Diam.	9.0	
▨	Solid Square	12.0	
⊡	Hollow " Thick. from 0 01 to 0.12 Diam.	6.8	
⯃	Solid Octagon	15.3	
⯄	Hollow " Thick. from 0.05 to 0.080 Diam.	8.9	
⊣⊢	Built Struts Av.Sec. $b=D$	10.4	
I	" " " "	10.2	
]-[	Channel Chord	6.5	8.0
]I[	Built "	7.0	8.0

Select the proper value of l/d in the left-hand column of the table, and follow a horizontal line from this until it reaches a vertical column, at the top of which is the proper value of d^2/r^2, and there will be found, at the intersection, a percentage value which is to be multiplied by the following constants (a) to obtain the allowable compressive strains in pounds per square inch:

20k. FOR MEDIUM STEEL, STATIC.
16k. FOR WROUGHT IRON, STATIC.
20k. " CAST " "

ALLOWABLE COMPRESSIVE STRAINS FOR TIMBER COLUMNS.

This table gives the percentages of compressive strength for different values of $\frac{l}{d}$, and the corresponding allowable strains per square inch of cross-section for different timbers.

$\frac{l}{d}$	Percentage.	White oak.	White pine.	Georgia pine.
15	81.6	1.31 k.	0.98 k.	1.47 k.
16	79.6	1.27 k.	0.96 k.	1.43 k.
17	77.5	1.24 k.	0.93 k.	1.40 k.
18	75.5	1.20 k.	0.91 k.	1.36 k.
19	73.5	1.18 k.	0.88 k.	1.32 k.
20	71.4	1.14 k.	0.86 k.	1.29 k.
21	69.4	1.11 k.	0.83 k.	1.25 k.
22	67.4	1.08 k.	0.81 k.	1.21 k.
23	65.4	1.05 k.	0.78 k.	1.18 k.
24	63.5	1.02 k.	0.76 k.	1.14 k.
25	61.5	0.99 k.	0.74 k.	1.11 k.
26	59.7	0.96 k.	0.72 k.	1.07 k.
27	57.8	0.93 k.	0.69 k.	1.04 k.
28	56.0	0.90 k.	0.67 k.	1.01 k.
29	54.2	0.87 k.	0.65 k.	0.98 k.
30	52.6	0.84 k.	0.63 k.	0.95 k.
32	49.4	0.79 k.	0.59 k.	0.89 k.
34	46.4	0.74 k.	0.56 k.	0.83 k.
36	43.6	0.70 k.	0.52 k.	0.79 k.
38	40.9	0.65 k.	0.49 k.	0.74 k.
40	38.5	0.62 k.	0.46 k.	0.69 k.
45	33.1	0.53 k.	0.40 k.	0.60 k.
50	28.6	0.46 k.	0.34 k.	0.52 k.
55	24.8	0.40 k.	0.30 k.	0.45 k.
60	21.7	0.35 k.	0.26 k.	0.40 k.
Column Formulas		$\frac{1.6\text{ k.}}{1+\frac{l^2}{1\,000\,d^2}}$	$\frac{1.2\text{ k.}}{1+\frac{l^2}{1\,000\,d^2}}$	$\frac{1.8\text{ k.}}{1+\frac{l^2}{1\,000\,d^2}}$

l = Length of column, in inches;
d = Least diameter of column, in inches.

Percentage of Increase to Live-Load Strains to Produce Static Equivalent, According to the Formula:

$$S = 125 - \frac{1}{8} \sqrt{2\,000\ L - L^2}$$

Where,

S = Increase, in percentage;

L = Length, in feet, of applied loading which produces maximum strain in the member.

Applied loads shall be increased according to their various lengths by the above formula to produce the Static Equivalent.

L.	*S.*	*L.*	*S.*	*L.*	*S.*	*L.*	*S.*
1	119.41	25	97.22	150	59.15	390	25.95
2	117.10	26	96.68	160	57.18	400	25.00
3	115.32	27	96.15	170	55.28	410	24.07
4	113.83	28	95.63	180	53.45	420	23.17
5	112.52	29	95.12	190	51.70	430	22.29
6	111.33	30	94.61	200	50.00	440	21.44
7	110.23	35	92.22	210	48.36	450	20.60
8	109.22	40	90.00	220	46.78	460	19.79
9	108.27	45	87.91	230	45.24	470	19.00
10	107.37	50	85.97	240	43.76	480	18.23
11	106.51	55	84.12	250	42.32	490	17.48
12	105.69	60	82.35	260	40.92	500	16.75
13	104.91	65	80.67	270	39.57	510	16.03
14	104.16	70	79.06	280	38.25	520	15.34
15	103.43	75	77.51	290	36.97	540	14.01
16	102.73	80	76.01	300	35.73	560	12.75
17	102.05	85	74.57	310	34.52	580	11.56
18	101.39	90	73.17	320	33.35	600	10.44
19	100.75	95	71.82	330	32.20	650	7.91
20	100.13	100	70.51	340	31.09	700	5.76
21	99.52	110	68.00	350	30.01	750	3.97
22	98.92	120	65.63	360	28.95	800	2.53
23	98.34	130	63.37	370	27.93	850	1.41
24	97.78	140	61.21	380	26.92	900	0.63

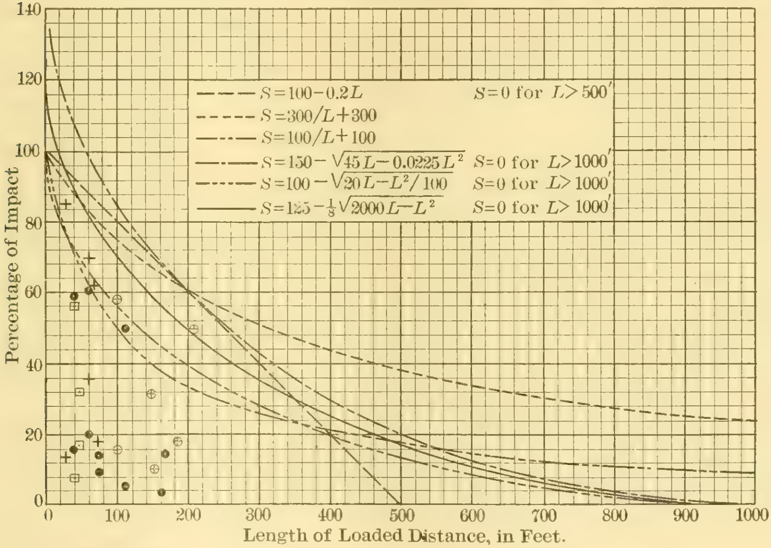
Where L = 1 000 ft. or more, $S = 0$.

DIAGRAM OF IMPACT FORMULAS

AND

TESTS MADE ON BRIDGES OF THE BALTIMORE AND OHIO RAILROAD.

(For Mr. Greiner's tests see *Proceedings*, Am. Ry. E. and M. of W. Assoc., Vol. 6, 1905.)



+ Plate Girders.

⊕ Bottom Chord of Trusses.

● Main and Counter-ties of Trusses.

⊡ Hangers.

Vibrations were not noticeable at speeds of less than 15 or 20 miles per hour.

FIG. 7.

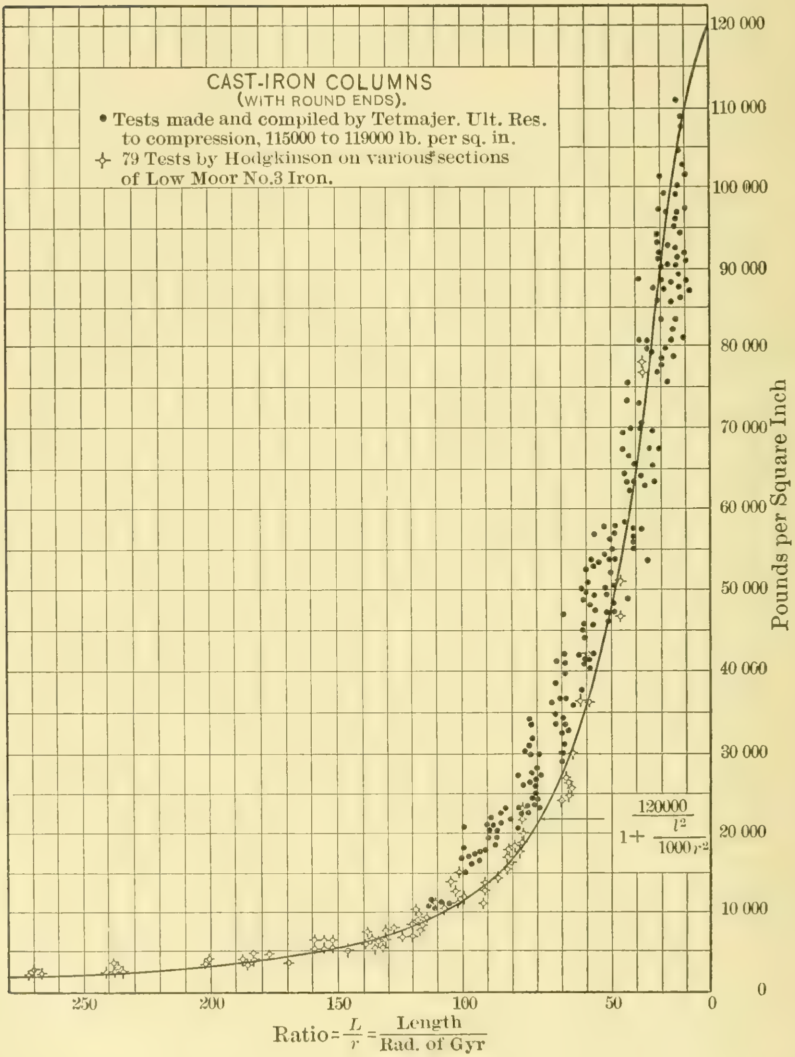

CAST-IRON COLUMNS
(WITH ROUND ENDS).
• Tests made and compiled by Tetmajer. Ult. Res. to compression, 115000 to 119000 lb. per sq. in.
✧ 79 Tests by Hodgkinson on various sections of Low Moor No.3 Iron.
$\frac{120000}{1+\frac{l^2}{1000r^2}}$
120 000
110 000
100 000
90 000
80 000
70 000
60 000
50 000
40 000
30 000
20 000
10 000
0
Pounds per Square Inch
250
200
150
100
50
0
Ratio $= \frac{L}{r} = \frac{\text{Length}}{\text{Rad. of Gyr}}$

FIG. 8.

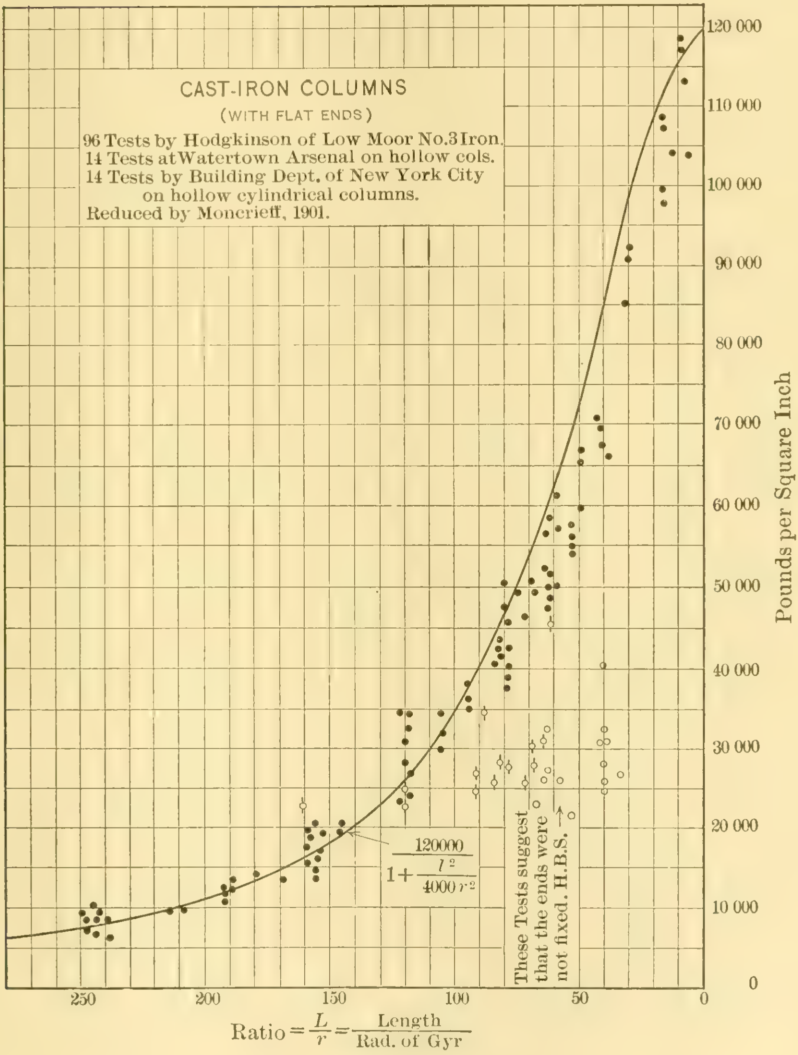

CAST-IRON COLUMNS
(WITH FLAT ENDS)
96 Tests by Hodgkinson of Low Moor No.3 Iron.
14 Tests at Watertown Arsenal on hollow cols.
14 Tests by Building Dept. of New York City
on hollow cylindrical columns.
Reduced by Moncrieff, 1901.
$\frac{120000}{1+\frac{l^2}{4000r^2}}$
These Tests suggest
that the ends were
not fixed. H.B.S. ↑
120 000
110 000
100 000
90 000
80 000
70 000
60 000
50 000
40 000
30 000
20 000
10 000
0
Pounds per Square Inch
250
200
150
100
50
0
Ratio = $\frac{L}{r}$ = $\frac{\text{Length}}{\text{Rad. of Gyr}}$

FIG. 9.

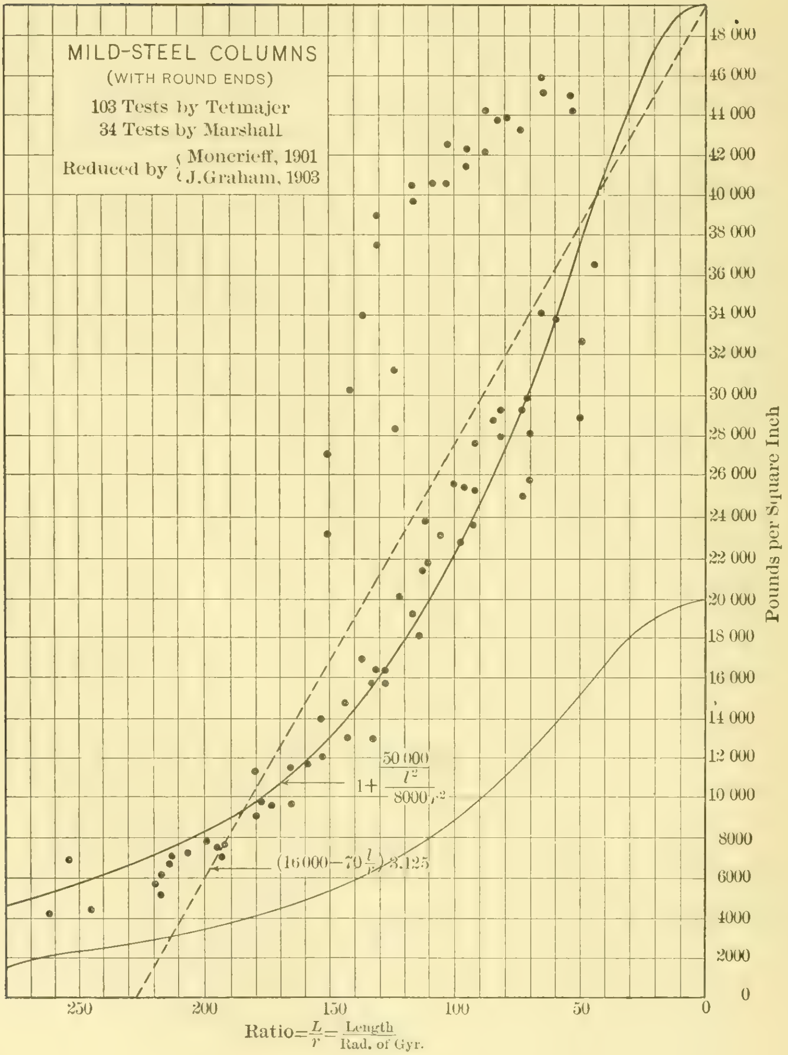

MILD-STEEL COLUMNS
(WITH ROUND ENDS)
103 Tests by Tetmajer
34 Tests by Marshall
Reduced by Moncrieff, 1901
J.Graham, 1903
$\frac{50000}{1+\frac{l^2}{8000 r^2}}$
$(16000-70\frac{l}{r})3.125$
48 000
46 000
44 000
42 000
40 000
38 000
36 000
34 000
32 000
30 000
28 000
26 000
24 000
22 000
20 000
18 000
16 000
14 000
12 000
10 000
8000
6000
4000
2000
0
Pounds per Square Inch
250
200
150
100
50
0
Ratio $=\frac{L}{r}=\frac{\text{Length}}{\text{Rad. of Gyr.}}$

FIG. 10.

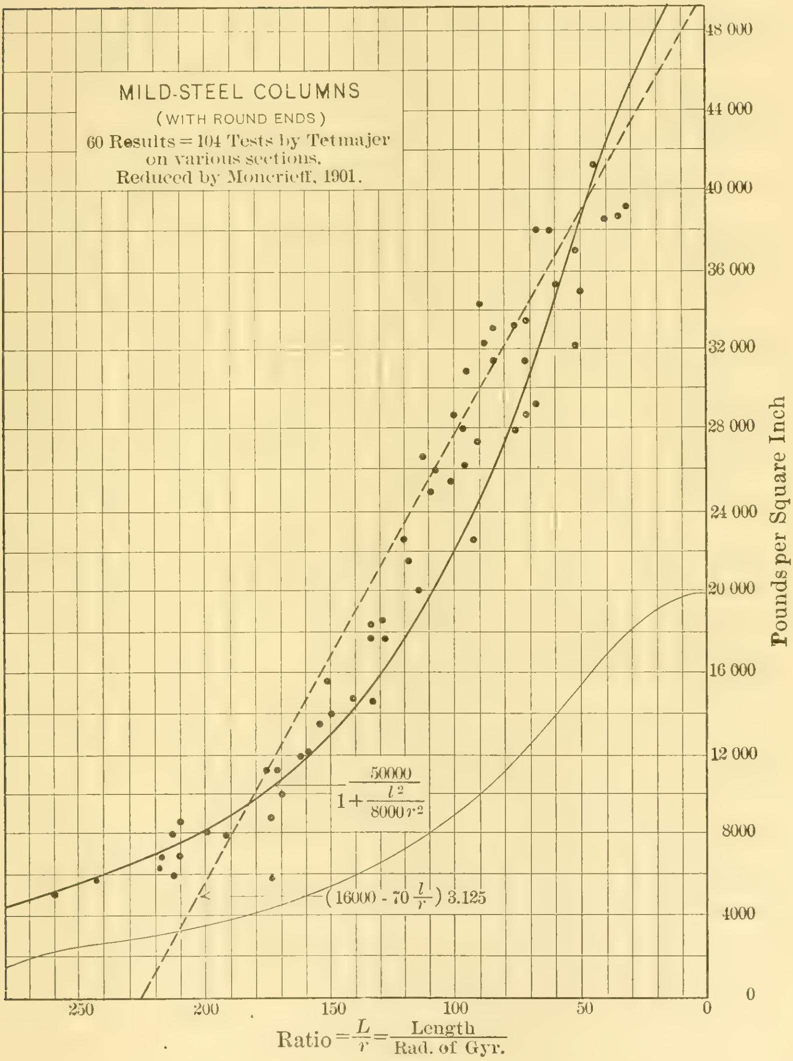

MILD-STEEL COLUMNS
(WITH ROUND ENDS)
60 Results = 104 Tests by Tetmajer
on various sections.
Reduced by Moncrieff, 1901.
50000 / 1 + l² / 8000 r²
(16000 - 70 l/r) 3.125
48 000
44 000
40 000
36 000
32 000
28 000
24 000
20 000
16 000
12 000
8000
4000
0
Pounds per Square Inch
250
200
150
100
50
0
Ratio = L/r = Length / Rad. of Gyr.

FIG. 11.

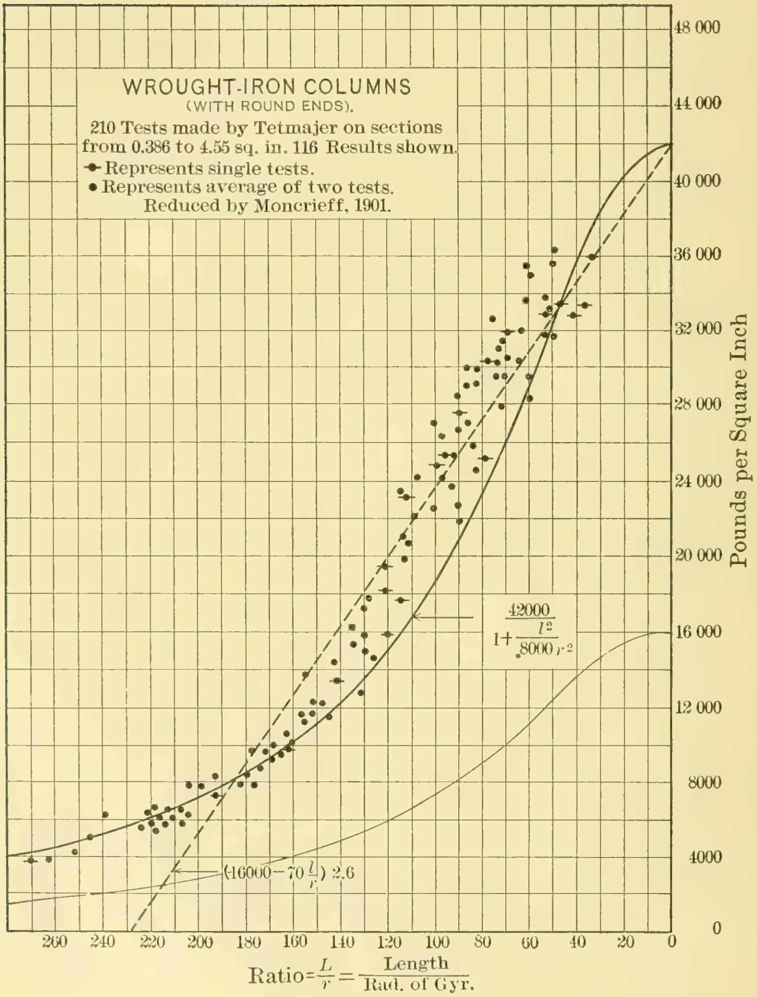

WROUGHT-IRON COLUMNS
(WITH ROUND ENDS).
210 Tests made by Tetmajer on sections from 0.386 to 4.55 sq. in. 116 Results shown.
-•- Represents single tests.
• Represents average of two tests.
Reduced by Moncrieff, 1901.
$\frac{42000}{1+\frac{l^2}{8000\,r^2}}$
$(16000-70\frac{l}{r})\ 2.6$
48 000
44 000
40 000
36 000
32 000
28 000
24 000
20 000
16 000
12 000
8000
4000
0
Pounds per Square Inch
260
240
220
200
180
160
140
120
100
80
60
40
20
0
Ratio $=\frac{L}{r}=\frac{\text{Length}}{\text{Rad. of Gyr.}}$

FIG. 12.

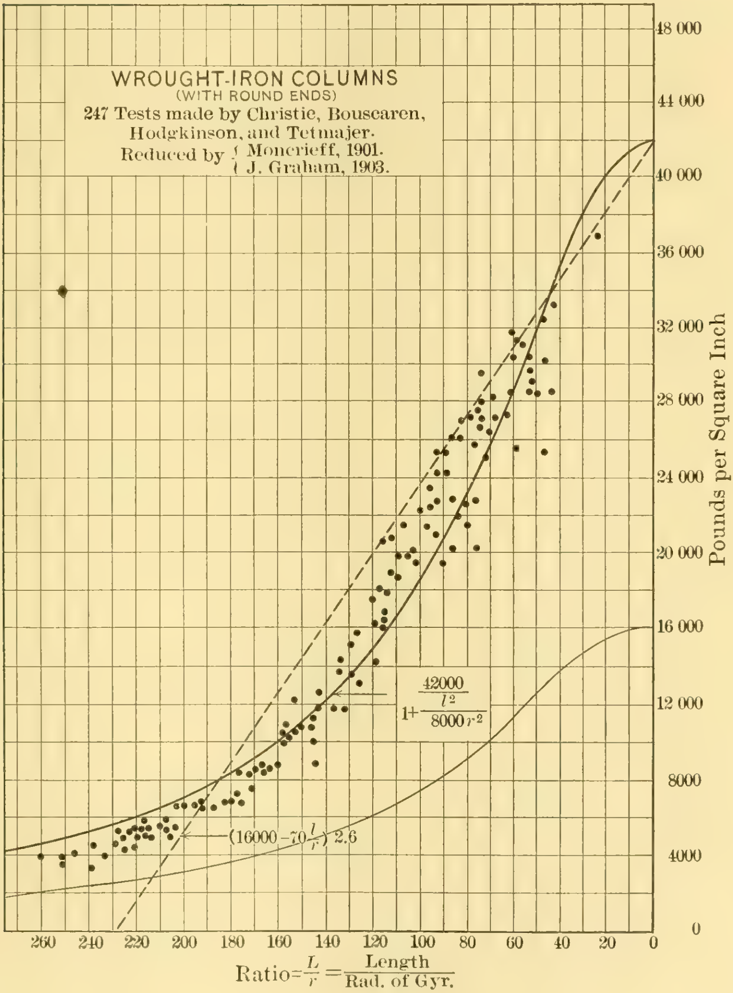

WROUGHT-IRON COLUMNS
(WITH ROUND ENDS)
247 Tests made by Christie, Bouscaren,
Hodgkinson, and Tetmajer.
Reduced by { Moncrieff, 1901.
{ J. Graham, 1903.
$\frac{42000}{1+\frac{l^2}{8000 r^2}}$
$(16000-70\frac{l}{r})\ 2.6$
48 000
44 000
40 000
36 000
32 000
28 000
24 000
20 000
16 000
12 000
8000
4000
0
Pounds per Square Inch
260
240
220
200
180
160
140
120
100
80
60
40
20
0
Ratio $=\frac{L}{r}=\frac{\text{Length}}{\text{Rad. of Gyr.}}$

FIG. 13.

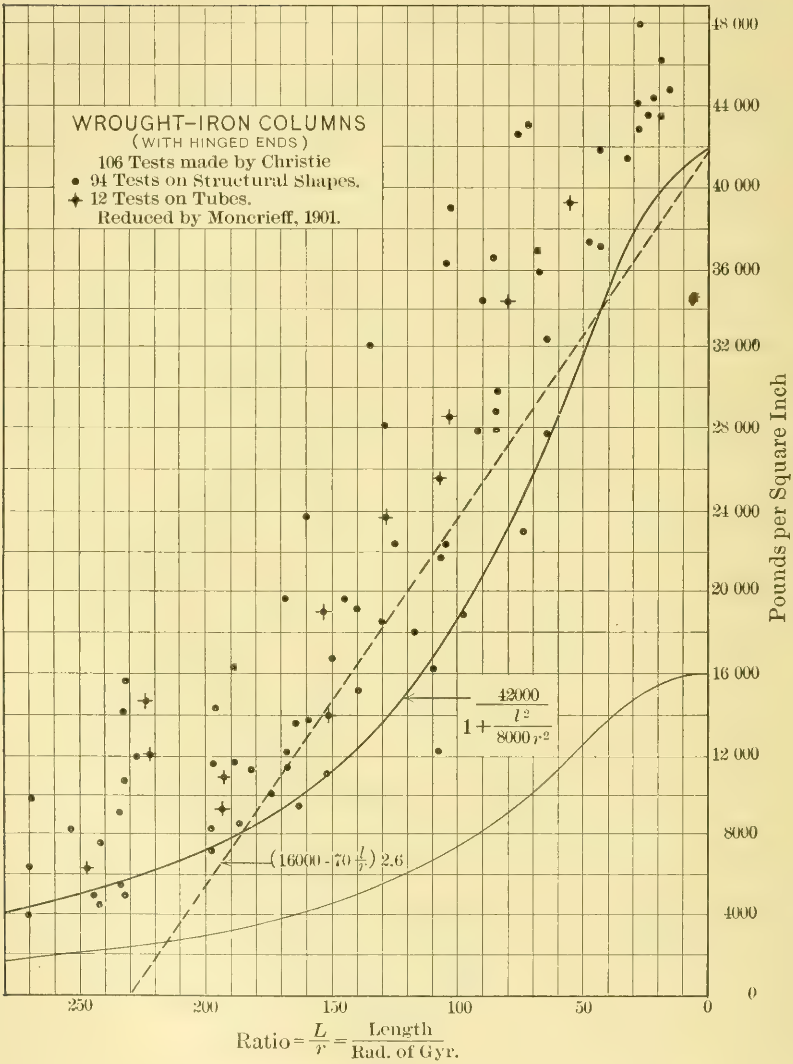

WROUGHT–IRON COLUMNS
(WITH HINGED ENDS)
106 Tests made by Christie
● 94 Tests on Structural Shapes.
✦ 12 Tests on Tubes.
Reduced by Moncrieff, 1901.
$\frac{42000}{1+\frac{l^2}{8000r^2}}$
$(16000-70\frac{l}{r})\,2.6$
48 000
44 000
40 000
36 000
32 000
28 000
24 000
20 000
16 000
12 000
8000
4000
0
Pounds per Square Inch
250
200
150
100
50
0
Ratio $=\frac{L}{r}=\frac{\text{Length}}{\text{Rad. of Gyr.}}$

FIG. 14.

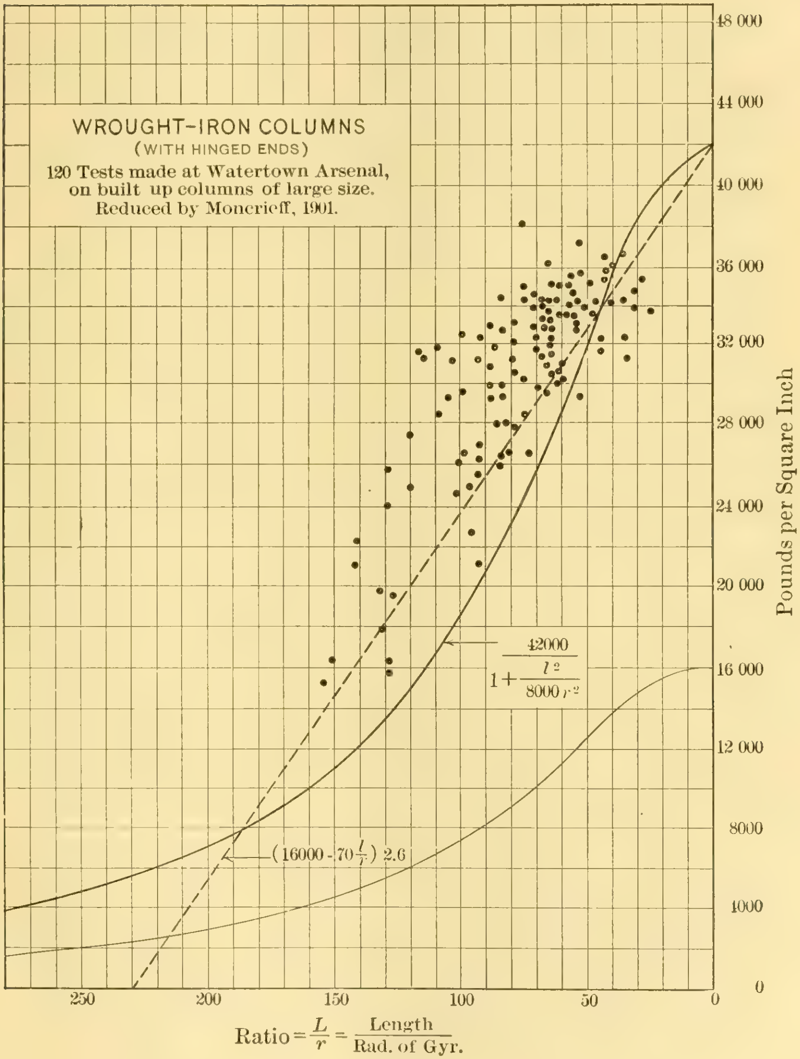

WROUGHT-IRON COLUMNS
(WITH HINGED ENDS)
120 Tests made at Watertown Arsenal,
on built up columns of large size.
Reduced by Moncrieff, 1901.
$\frac{42000}{1+\frac{l^2}{8000\,r^2}}$
$(16000 - 70\frac{l}{r})\ 2.6$
48 000
44 000
40 000
36 000
32 000
28 000
24 000
20 000
16 000
12 000
8000
4000
0
Pounds per Square Inch
250
200
150
100
50
0
Ratio = $\frac{L}{r}$ = $\frac{\text{Length}}{\text{Rad. of Gyr.}}$

FIG. 15.

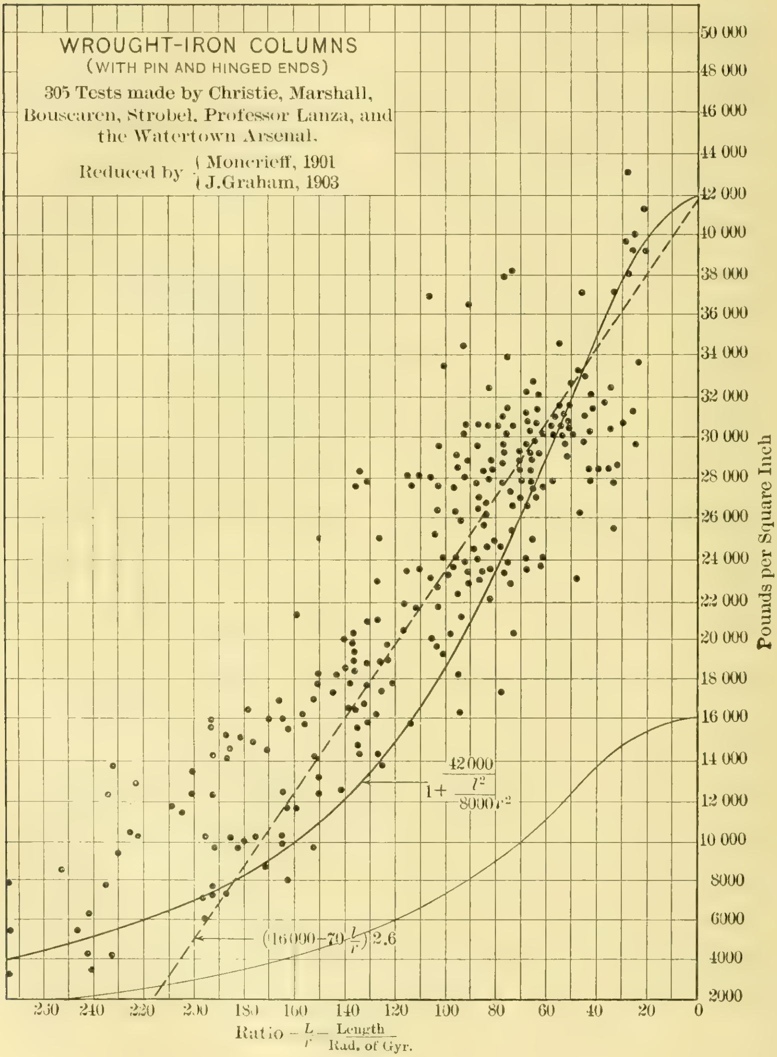

WROUGHT-IRON COLUMNS
(WITH PIN AND HINGED ENDS)
305 Tests made by Christie, Marshall, Bouscaren, Strobel, Professor Lanza, and the Watertown Arsenal.
Reduced by { Moncrieff, 1901 / J. Graham, 1903
$\frac{42000}{1+\frac{l^2}{8000r^2}}$
$(16000-70\frac{l}{r})$ 2.6
Pounds per Square Inch
50 000
48 000
46 000
44 000
42 000
40 000
38 000
36 000
34 000
32 000
30 000
28 000
26 000
24 000
22 000
20 000
18 000
16 000
14 000
12 000
10 000
8000
6000
4000
2000
250
240
220
200
180
160
140
120
100
80
60
40
20
0
Ratio $\frac{L}{r}$ = $\frac{\text{Length}}{\text{Rad. of Gyr.}}$

FIG. 16.

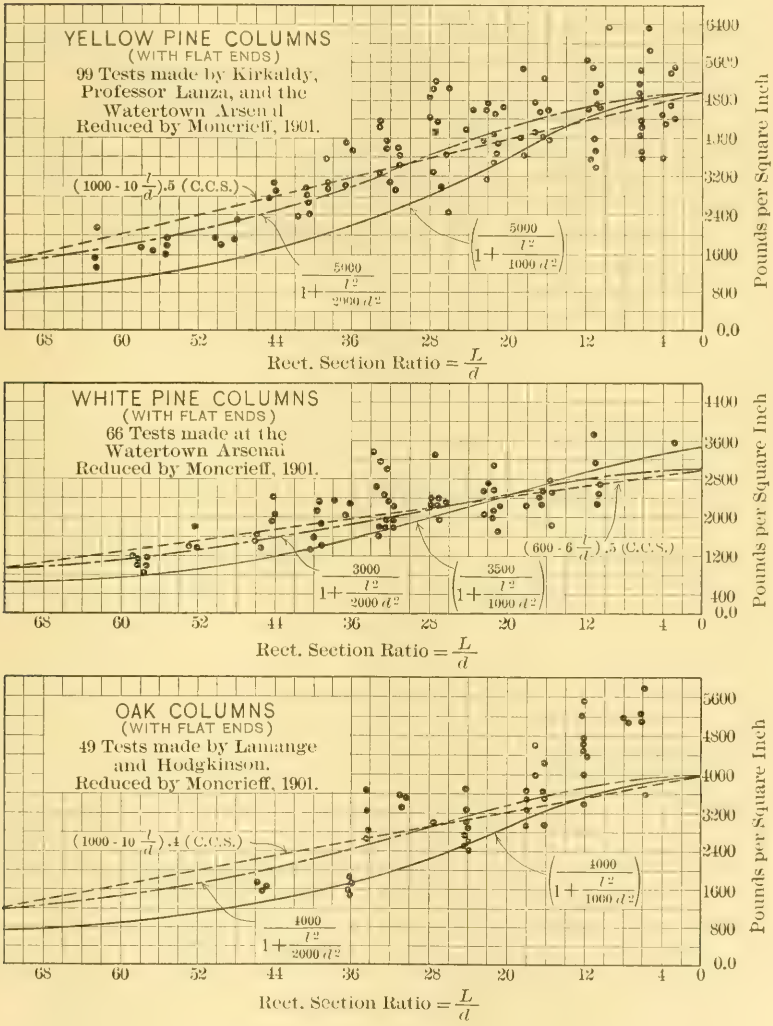

YELLOW PINE COLUMNS
(WITH FLAT ENDS)
99 Tests made by Kirkaldy, Professor Lanza, and the Watertown Arsenal
Reduced by Moncrieff, 1901.
(1000 - 10 l/d).5 (C.C.S.)
5000 / (1 + l²/2000 d²)
5000 / (1 + l²/1000 d²)
6400
5600
4800
4000
3200
2400
1600
800
0.0
Pounds per Square Inch
68
60
52
44
36
28
20
12
4
0
Rect. Section Ratio = L/d
WHITE PINE COLUMNS
(WITH FLAT ENDS)
66 Tests made at the Watertown Arsenal
Reduced by Moncrieff, 1901.
(600 - 6 l/d).5 (C.C.S.)
3000 / (1 + l²/2000 d²)
3500 / (1 + l²/1000 d²)
4400
3600
2800
2000
1200
400
0.0
Pounds per Square Inch
68
60
52
44
36
28
20
12
4
0
Rect. Section Ratio = L/d
OAK COLUMNS
(WITH FLAT ENDS)
49 Tests made by Lamange and Hodgkinson.
Reduced by Moncrieff, 1901.
(1000 - 10 l/d).4 (C.C.S.)
4000 / (1 + l²/2000 d²)
4000 / (1 + l²/1000 d²)
5600
4800
4000
3200
2400
1600
800
0.0
Pounds per Square Inch
68
60
52
44
36
28
20
12
4
0
Rect. Section Ratio = L/d

FIG. 17.

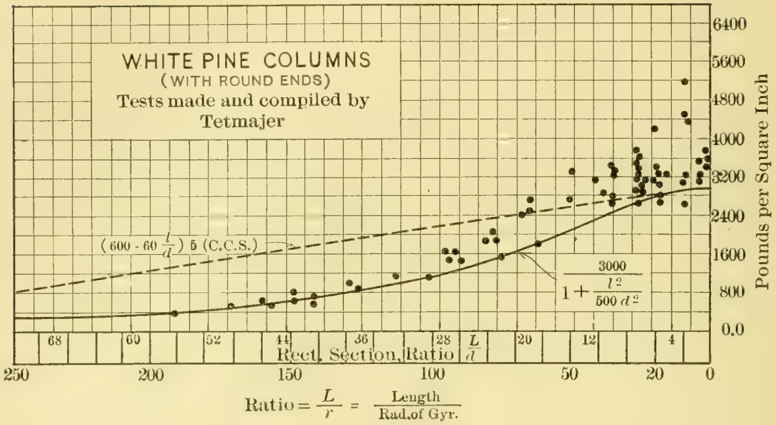

WHITE PINE COLUMNS
(WITH ROUND ENDS)
Tests made and compiled by
Tetmajer
$(600 - 60 \frac{l}{d})\ 5$ (C.C.S.)
$\frac{3000}{1 + \frac{l^2}{500 d^2}}$
6400
5600
4800
4000
3200
2400
1600
800
0.0
Pounds per Square Inch
68
60
52
44
36
28
20
12
4
Rect. Section, Ratio $\frac{L}{d}$
250
200
150
100
50
20
0
Ratio = $\frac{L}{r}$ = $\frac{\text{Length}}{\text{Rad.of Gyr.}}$

FIG. 18.

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AMERICAN SOCIETY OF CIVIL ENGINEERS

INSTITUTED 1852

PAPERS AND DISCUSSIONS

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NOTES ON A TUNNEL SURVEY.

By Frederick C. Noble, M. Am. Soc. C. E.

To be Presented February 7th, 1912.

The following is a description of the surveying methods used in constructing the tunnel under the East River between South Ferry, Manhattan, and Joralemon Street, Brooklyn. This tunnel was begun in March, 1903, and was opened to traffic in January, 1908.

The tunnel consists of two parallel single-track tubes, of the usual cast-iron ring construction, having an interior diameter of 15 ft. 6 in. Under the river their distance from center to center is 28 ft., and under Joralemon Street, it is 26 ft.

The Manhattan headings were driven from a double shaft in Battery Park, near the ferry. Rock was encountered until the headings reached the lowest point of grade, near the middle of the river, after which the advance was continued with shields. The Brooklyn headings, for which shields were used from the start, were driven from two shafts, one over each tube, situated in Joralemon Street about 1 200 ft. back from the water front, at the point where the tunnel grade rises above water level. Under Joralemon Street the material encountered was rather coarse sand, containing gravel, cobbles, and boulders. Under the

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Note.—These papers are issued before the date set for presentation and discussion. Correspondence is invited from those who cannot be present at the meeting, and may be sent by mail to the Secretary. Discussion, either oral or written, will be published in a subsequent number of *Proceedings*, and, when finally closed, the papers, with discussion in full, will be published in *Transactions*.

In the *Proceedings* of this Society, the Papers and the Discussions on Papers will hereafter be printed so that each will commence on an odd-numbered page. This is done by special request, in order to enable members who wish to do so to separate the Papers and Discussions for filing under various engineering subjects.

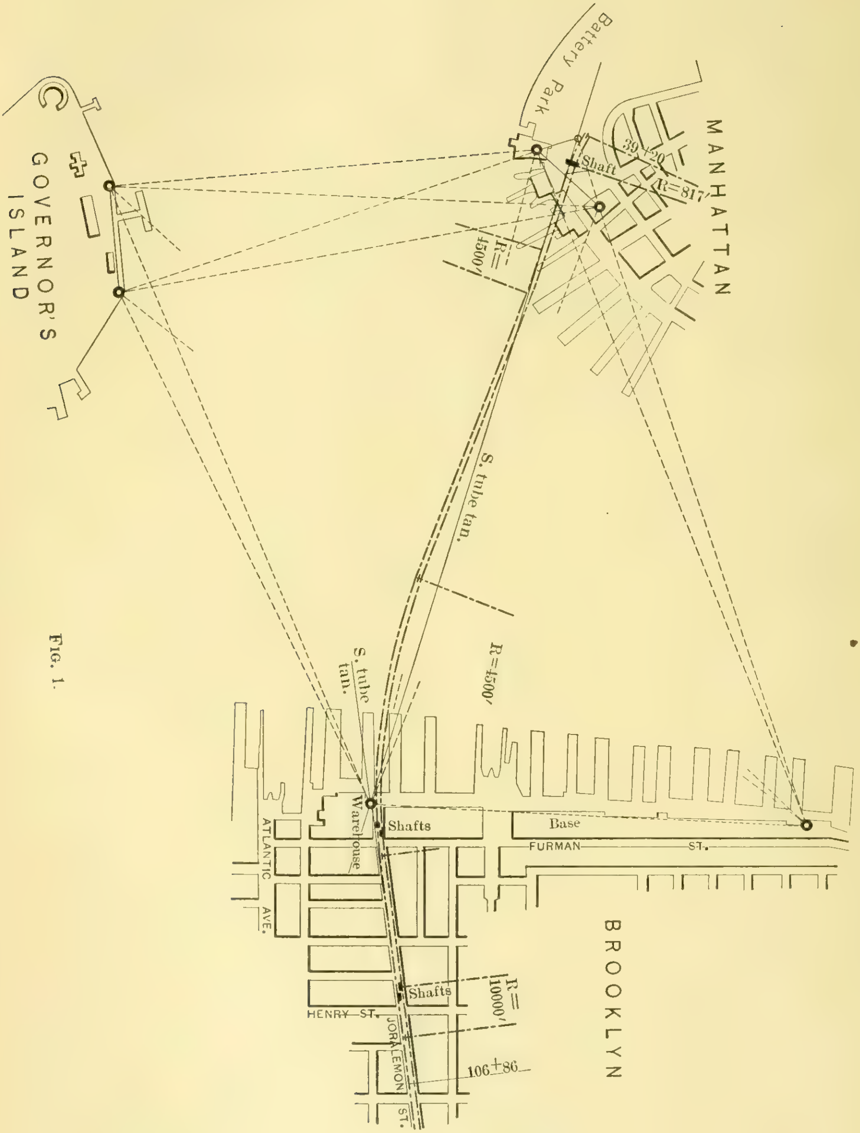
GOVERNOR'S ISLAND
Battery Park
MANHATTAN
Shaft
39+20
R=817'
R=4500'
S. tube tan.
S. tube tan.
R=4500'
Warehouse
Shafts
Base
FURMAN ST.
ATLANTIC AVE.
Shafts
R=10000'
HENRY ST.
JORALEMON ST.
106+86
BROOKLYN

FIG. 1.

river, except for a few hundred feet where the Brooklyn shields were slid through upcropping rock, the sand was extremely fine and of the same nature as the quicksand generally found in excavating for deep foundations in the lower part of Manhattan. The meeting of the Manhattan and Brooklyn shields took place in the fine sand midway between the two rock formations. The tunneling was all in compressed air, except in the Brooklyn headings above water level east of the shafts, and except inside the bulkhead line at South Ferry. The maximum air pressure was 42 lb. per sq. in. above atmosphere.

Between the Manhattan and Brooklyn shafts, a distance of about 6 000 ft., there are three tangents in the tunnel line, the middle or river tangent being joined to the Manhattan and Brooklyn tangents by curves of 4 500 ft. radius. (Fig. 1.) The grade on each side is 3.1%, joined at the middle by a short grade of 0.5% sloping up toward Brooklyn. The grade tangents are connected by vertical curves of 20 000 ft. radius. (Fig. 2.)

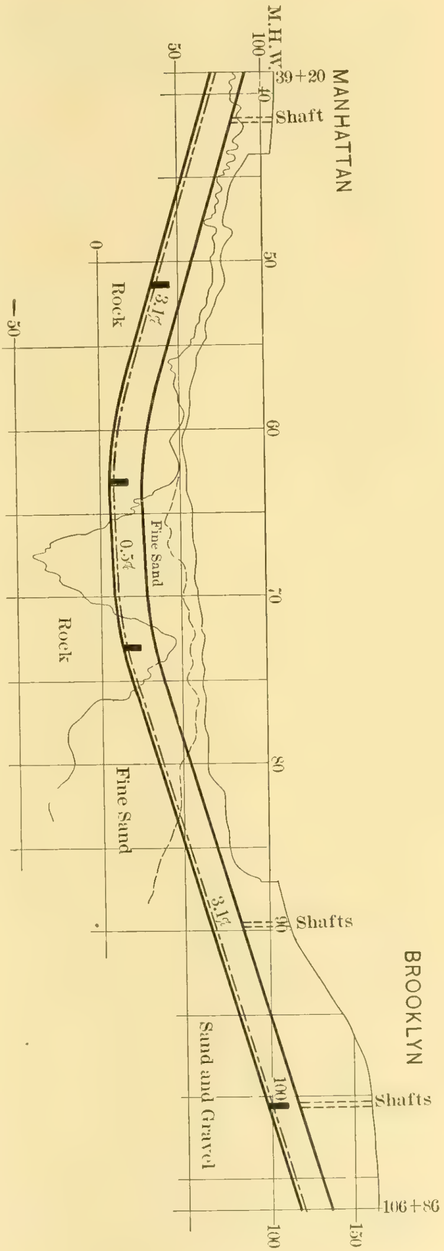

FIG. 2.

The intersection of the south tube lines of the Joralemon Street tangent and the Manhattan tangent produced was located on the roof of a dock warehouse at the foot of Joralemon Street. It was necessary to determine the exact distance between this intersection and a point of known stationing on the south tube line in Manhattan, and this required a triangulation survey. It was apparent that no base line of suitable length could be laid out in the vicinity that could be measured directly from end to end as one of the sides of the triangulation system. Although the ends could be located on roofs, so as to be seen from each other, the measurement had to be made along a broken line. A reconnaissance showed that a practicable base, about 3 000 ft. long, might be obtained on the Brooklyn water front north of Joralemon Street. The southern terminus was chosen to be the above-mentioned intersection of the south tube lines, and the northern terminus was also located on the roof of a warehouse. Each of these points commanded a view of each other and of the adjoining water fronts of Manhattan and Governor's Island, and, accordingly, were suitable for triangulation stations. In Manhattan, because of intervening buildings, it was found impracticable to locate a triangulation station on the south tube line in the vicinity of the shaft so that it would be visible from all the other stations. On this account two elevated points on the roofs of near-by buildings, one on each side of the Manhattan tangent, were chosen as triangulation stations, and carefully referenced to the point of known stationing on the south tube line, which was visible from them. On Governor's Island, on the northerly sea-wall, two triangulation stations were chosen which marked the extremities of a shorter base used two seasons before in making a preliminary triangulation of the tunnel line. It was desired to include this base in the system so as to have an independent check on the Brooklyn base measurement.

The foregoing arrangement gave four fairly well proportioned quadrilaterals, the Brooklyn base forming one common side. In the system there were no angles of less than 26° or more than 78°, and the ratio of length of base to the distance sought was about 1 : 1½. By having four quadrilaterals from which to calculate the co-ordinates of the Manhattan points, referred to the Brooklyn base as the axis, it was thought that any material error in the angular work could be detected, and this would give a measure of the error to be regarded as unavoidable.

The base line traverse was measured with a 50-ft., flat, steel-wire tape, provided with a spring-balance handle containing a level bubble, thermometer, and adjustment for temperature correction. It was marked with nicks at each end for use with plumb-bobs. The tape was tested for absolute length by comparison with a standard tape of known error, as determined by the Bureau of Standards at Washington. Measurements were made on cloudy days, or during early mornings in the shade, to secure uniform temperature conditions. The line was marked in advance every 50 ft., and paper pads, ruled with a longitudinal line, were weighted down at these points, so as to relieve the head chainman of the distraction of getting line from a transit. Each measurement was made by simultaneous plumbings at the ends of the tape, which was held level. The forward point was marked at the average of a number of trials. For each series of measurements a fresh sheet of the pad was used. With a tape of this kind the difficulty of steady and precise plumbing was such that no individual measurement could be depended on to less than 0.003 ft., or 1 in 17 000. No doubt a better method consists in using a longer tape, supported at short intervals, with a tape-stretcher, and measuring directly, without plumbing, on portable stations, as was done later in connection with other tunnel surveys in New York. However, with care, it was found that the errors were not cumulative, and, in a distance of 2 880 ft. measured in this way, the variation between the mean and the greatest extreme of several measurements was only about 1 in 100 000. The ends of the line measured on the docks were connected to the triangulation stations on the roofs in two different ways, in order to avoid repeating an error. The points on the copings were transferred to the dock level by casting down intersecting lines of sight from three transit set-ups. As a further check, an independent traverse, closing on the same points, was run by a different party in the marginal street back of the warehouses, and this gave a result agreeing with the dock traverse to 1 in 150 000.

The triangulation sights were octagonal pine poles, 2¼ in. in diameter and 8 ft. high, painted in alternate bands of red and white. While these could be bisected readily, and gave no sensible difficulty from phase, because of the comparatively short range and the cloudy weather selected for instrumental work, it would have been better practice to use higher targets with wide, flat vanes, set alternately at right angles.

The angles were read separately by two observers, with different instruments. These were ordinary engineers' transits, reading to 20″ on a $6\frac{1}{4}$-in. limb. The eight angles of a quadrilateral were measured separately by successive additions upon the limb. The entire angle at a station was also read, as a check on the sum of its components. To avoid bias, the angles were started at random near zero. Turnings were made, accumulating from left to right, until the sum became as nearly as practicable 360°, or its multiple. Reversing the telescope, and setting on the right-hand target, the same number of turnings was made from right to left until the sum was diminished to near the original reading. Both verniers were read at the beginning, at the middle, at intermediate points, and at closing. In case an angle failed to close nearer than an average of 4″ to each turning, the result was discarded and the angle was read again. When the third angle of any triangle of the system had been read, the angles were added, and if their sum varied from 180° by more than an average of 5″ for each angle, the three angles were read again. The quadrilaterals were tested in like manner. It was found necessary to read over only one triangle, and in this case the trouble was located at a station where the conditions for observing had been less favorable than elsewhere.

In comparing the observed angles, it was noted that the direct reading of an angle was generally greater, by 2″ or 3″, than its value as found by taking the difference between two angles, and that, at the end of an observation, the closing reading was nearly always greater than the first. As this pointed to a small persistent error, it was seen that it would have been a better programme to measure each angle both directly and by its 360° complement, and to take the mean.

The set of observed angles of each quadrilateral was adjusted by the method of logarithmic residuals, based on the principle of least squares, according to Johnson, and using the rigid method of making the side equation correction. The angles read by each observer were adjusted separately. The corrections for spherical excess and reduction to sea-level were omitted as insignificant.

The four quadrilaterals formed four pairs, each with a common triangle. These relations would give rise to additional equations of condition, and the simultaneous adjustment of all four quadrilaterals would be possible, theoretically. However, this was not attempted because the refinement would not pay for the effort, and because it was desired to compute each quadrilateral separately adjusted, so as to gain a practical idea of the effects of error in the angular work.

For the purpose of comparing results, the co-ordinates of the Manhattan and Governor's Island stations, referred to the Brooklyn base, were then computed for each of the four adjusted quadrilaterals of each observer. On plotting to full size it was found that for any point the various positions thus computed fell within the section of the target pole. It was seen that considerable time and labor would have been saved (and with sufficiently accurate results) by using any one quadrilateral, but the advantage of learning in this way the probable extent of errors from all causes was thought to warrant the extra trouble.

The sides of the triangle formed by the two Manhattan triangulation stations and the point of known stationing in Battery Park were then measured, and the co-ordinates of the latter point were computed from those of the other two. The distance triangulated for was then determined. The computed length of the Governor's Island base, about 700 ft., was found to agree with its original measured length within 0.016 ft., or much less than the probable angular error would account for.

The stationing of the Brooklyn intersection of the south tube tangents then being known, base-tape measurements were made from this point to the Brooklyn shafts. Stationing was transferred to the tunnel by plumbing in the shafts. All measurements, above and below ground, to determine stationing in the tubes, were made with the same kind of tape as that used for measuring the base, and in a similar manner. When the first headings were connected, the measured distance was found to be about 0.02 ft. short of that calculated. The discrepancy was somewhat more than had been expected, but may be adequately accounted for as combining the error in angular work with the error due to the difference in conditions, with the apparatus used, between taping in the tunnel and taping the base line on the surface. Its effect on the results of the surveys for alignment and grade, however, was very slight.

For establishing the Manhattan tangent alignment, there was no point on line in Battery Park, near the shaft, that was high enough to afford a sight to Brooklyn over the intervening ferry-houses. For this purpose, two towers, about 35 ft. high, one on each tube line, were erected about 150 ft. west of the shaft. From these it was possible to look across the river over all obstructions and see targets on the warehouse roof in Brooklyn set on the Manhattan tube lines prolonged. The towers were built as triangulation towers usually are: with an interior tripod of three 8 by 8-in. timbers rigidly bolted together at the top and braced; this being enclosed within, but nowhere touching, a four-post tower braced on all sides and supporting a platform for the observer a little below the top of the tripod.

Line was transferred to the tunnel in the following manner: A transit, mounted on a trivet, was set on the tower tripod on the tube center line, as plumbed up from a hub under the tripod by several reversals of another transit set on the center line a short distance away. The tower transit, fore-sighting on the Brooklyn target, set, by repeated plungings, a point on center line on the surface, about 10 ft. beyond the shaft. On this point a transit was set up, with its plumb-string in the mean position of the several settings, and, fore-sighting on the plumb-string of the tower transit, aligned two plumb-wires suspended in the shaft.

Steel piano wire, $\frac{1}{50}$ in. in diameter, was used for this purpose. It was wound on brass reels 9 in. in diameter. The reels were set, with their axes across the line, on stringers attached to the head-frame posts, high enough to permit sighting on the wires and to fore-sight by merely changing the focus. As the wire left the reel it ran over a small grooved wheel on a threaded axis, turned with a thumb-screw, by which slow lateral adjustment could be given. The wire was kept taut by a 20-lb. weight suspended in a pail of water at the bottom of the shaft.

The wires were shifted laterally until the vertical hair exactly bisected the plumb-string fore-sight and both plumb-wires. When this condition was reached, a transit, set up in the tunnel below, as close to the wires as practicable, was shifted laterally until its vertical hair exactly bisected both wires, and reversing, threw the line forward, setting two or more plummet-lamps hung from verniers reading on graduated brass scales attached to the roof of the tunnel. Resetting on the wires, another set of readings was taken. Two more sets were taken in like manner with telescope reversed. The wires were then shifted and reset by the upper transit, and the previous operations were repeated for four more sets. The whole of the foregoing operations was then repeated, after interchanging transits at top and bottom, turning the water pails containing the weights partly around, shifting the wires, examining them to see that they hung free, and interchanging the members of the party. This work of plumbing the lines down the shaft was usually done on Sundays, when the cages were not running.

At the Brooklyn shafts, the same method was followed, but the first part of the operation was simpler because the warehouse targets could be sighted directly from the surface at the shafts.

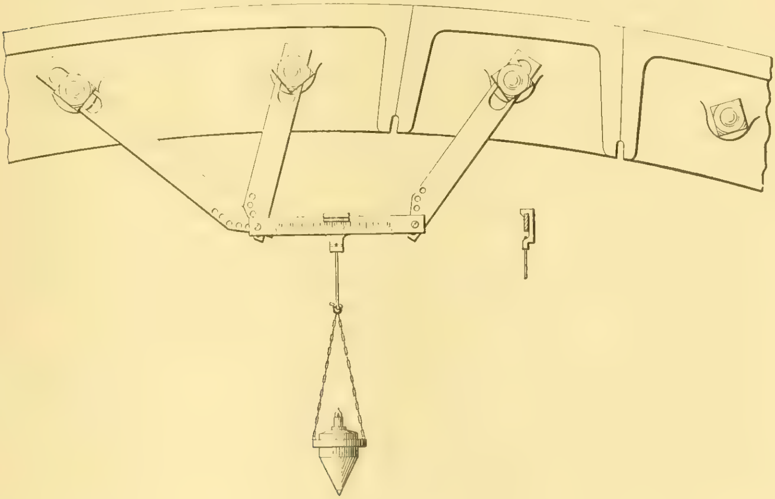

FIG. 3.

The base between the wires was about 10 ft. at the Manhattan shaft and 15 ft. at the Brooklyn shafts, and in each case was as long as permitted by the width of the shaft. On account of the shorter base in Manhattan, and the extra operation there in transferring line, opportunity was taken, when the headings were afterward extended west from the shaft, to check the line by plumbing through a vertical 6-in. pipe sunk from the surface to the tunnel at a point on the center line of one of the tubes, about 130 ft. from the shaft.

The alignment scales were brass bars, 1 in. wide, $\frac{1}{4}$ in. thick, and 10 in. long, graduated to 0.01 ft. They were connected by three flat iron bars to the bolts of the tunnel lining at the roof. (Fig. 3.) The scales were read to 0.002 ft. by a sliding vernier from which a plummet-lamp was suspended.

The line established on the scales near the shaft, as the mean result of many days' droppings, was produced by repeated runs read on scales set at intervals of about 200 ft. These runs were made by different observers, and using different transits, until mean readings were well established on the advance scales. Where the tube was on a curve, the scales were placed on tangents as long as could be obtained, and usually near points of intersection. The angles at these points were carried forward by repeated turnings on the forward scales.

When it became necessary to carry the line through a lock, the transit was placed on a trivet on a timber wedged across the lock at the forward end, where it had the support of the bulkhead wall. It was then lined in with the last two scales, the forward one having been located as close as practicable to the lock, and a reading was taken on a paper scale set inside the lock over the outboard door. The lock was then taken in, and, before throwing the line ahead, the paper scale was read again to detect any possible movement due to change in pressure. No trouble was ever experienced on this account, however, and when the bulkheads were advanced the lines thus locked through checked quite satisfactorily with lines carried through in free air.

To assist in aligning a transit with two given points, a very useful device was furnished by the instrument maker. This consisted of two sliding plates, which were attached between the transit base and the tripod head or trivet, and permitted considerable range of lateral movement by a slow-motion screw.

Grade was established between the two sides of the river as follows: Level runs were made from the shafts on each side to benches under the Brooklyn Bridge on the river side of each tower, at which point the river is much narrower than at the tunnel line. Levels were set up on each side, and simultaneous reciprocal readings were taken a number of times. The instruments were then interchanged and the readings repeated. In this way errors due to refraction, curvature, and imperfect adjustment were compensated.

Levels were transferred down shafts by reading on a tape hung in the shaft, and applying the required corrections. To guard against errors of method in using a tape in this way, a test was made by hanging the tape in the stair-well of a high building and comparing elevations obtained thus with those obtained by pegging up and down the stone steps with level and rod. Tunnel benches were generally located on lugs or cross-flanges near the lower quarter point of the tube.

Conditions for instrumental work in the tunnel were at times as good as could be desired, but at other times fog, powder smoke, and heat interfered seriously with the work. Much trouble was caused by scales being removed or disturbed, and, where this was likely to occur, they were boxed around. The zero points of scales were referenced to chisel cuts in the flanges of the lining. Where the tubes were in soft material, with one considerably in advance, the passage of the second shield would disturb the scales in the other tube.

When the Brooklyn headings had progressed about 1 000 ft. along the tangent, and part way around the curve to the foot of Joralemon Street, caissons were sunk at this point and connected to the tops of the tubes to form new shafts. To locate the corners of each caisson and to guide it during sinking, an underground traverse, tying in the corners of the roof opening, provided for by special segments, was reproduced on the surface. On making the connection the instrumental work checked closely.

These shafts afforded an opportunity to check the survey work thus far run, directly from the surface, and this was done with very satisfactory results. As the headings advanced on either side of the river, cross-connections were made between the tubes at certain points, giving an opportunity to compare the alignment, levels, and measurements carried forward in one tube with those carried forward independently in the other. There were three of these connections: two in rock on the Manhattan side, and one in the rock reef on the Brooklyn side.

The north headings were the first to meet under the river, and this was in December, 1906. When the shields were still 90 ft. apart, a 6-in. pipe was driven from the Brooklyn to the Manhattan side, by jetting and jacking, and the lines and grades were checked through. The pipe was driven straight enough to afford a clear sight from end to end, and, although somewhat off center line, was almost perfectly level, so that readings for grade could be made through it. A transit set up at each end produced the line through the pipe to the two forward scales in each heading, by which means the two center lines were found to be exactly parallel and 0.13 ft. apart. Of this discrepancy, about one-fourth could be attributed to the discrepancy of 0.2 ft., before mentioned, between the triangulated and measured distance across the river. The grades checked through the pipe within 0.01 ft.

The south headings, which had been keeping some distance behind the corresponding north headings, met in March, 1907. As the south shields were approaching to a junction, it was possible to reference the center line of each heading to the joined and corrected center line of the north tube. This was effected by pushing rods of a measured length through grout holes in the south side of the north tube until they brought up against the shell of the south tube at points which were then located and measured to. In this way the center lines of the south headings were brought together with an error of only 0.01 ft.

The greater part of the instrumental work in the tunnel consisted of giving the contractor lines and grades for the guidance of the shields and rock headings, and for the erection of the cast-iron lining of the tubes. A profile of the center line, taken at the top on the flanges of the rings, was kept posted up on a cross-section sheet in the contractor's office near the shaft, and a similar record was plotted for line. Where the lining was erected behind a shield, the transit and level were used directly for giving working lines and grades, and no simpler method could be devised that would answer the purpose, because it was found that the reaction of the shield jacks would disturb the lining for a considerable distance back. Where the headings were in rock, working points were given by lining in with the eye the flames of two plummet-lamps, hung from the roof by chains of adjustable length, and set so as to indicate grade as well as line. These lamps were made of a short piece of iron pipe, capped at the bottom, reduced at the top for a wick, and provided with a bail. They were suspended from hooks screwed in roof plugs, timber caps, or wedges in caulking recesses, with a piece of sash chain and an adjustable section made of two strips of brass, by which the length of suspension was varied. This arrangement was set by the line and grade party during the day shifts, and was ready for use by the inspectors at all times for erecting the rings, for giving points in rock headings, and for setting roof timbering.

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AMERICAN SOCIETY OF CIVIL ENGINEERS

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PAPERS AND DISCUSSIONS

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THE DETROIT RIVER TUNNEL.

Discussion.*

By Olaf Hoff, M. Am. Soc. C. E.

Olaf Hoff, M. Am. Soc. C. E. (by letter).—When the firm with which the writer was connected in February, 1906, received invitations to submit proposals for the construction of the Detroit River Tunnel, he immediately and with assiduity set to work on this intensely interesting problem. At that time he had no knowledge of the numerous patented inventions for building subaqueous tunnels in a trench in the bottom of a river or waterway, and, in fact, was under the impression that the Board of Engineers was the first to suggest this unique scheme. Later, having occasion to look the matter up, he was surprised to find a number of patents on such tunnels, mostly impracticable schemes, of doubtful merit, not one of which was ever carried out. Mr. Hoff.

Little or no attention was given to Design *D,* which would be eliminated as less advantageous, provided it were possible to build the tunnel in a trench, as contemplated by Designs *A, B,* and *C,* submitted by the Board of Engineers.

Accordingly, a careful study of these was made to determine their practicability, and especially to discover the objectionable features, if any, which might make their execution difficult, hazardous, or unreasonably expensive.

These designs are shown in cross-section on Plate CLX. They contemplated a tunnel 2 ft. less in diameter than the one built. In the

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* Continued from November, 1911, *Proceedings.*

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Mr. Hoff. specifications sent out to bidders, the designs were described as follows:

"Design *A* may be briefly described as a method by which the pervious material underlying the river is replaced by an imperfectly water-tight material of concrete placed under water, through which without the use of shields, the inner tubes or tunnel proper may be constructed so as to secure water-tightness, continuity of strength, and good workmanship, with an absence of high air pressures."

"Design *B* may be briefly described as a method by which the inner tubes of the tunnel proper are first built in floats or on dry land, floated and sunken into position on a proper foundation, and joined together by a suitable method so as to secure continuity of construction and water-tightness."

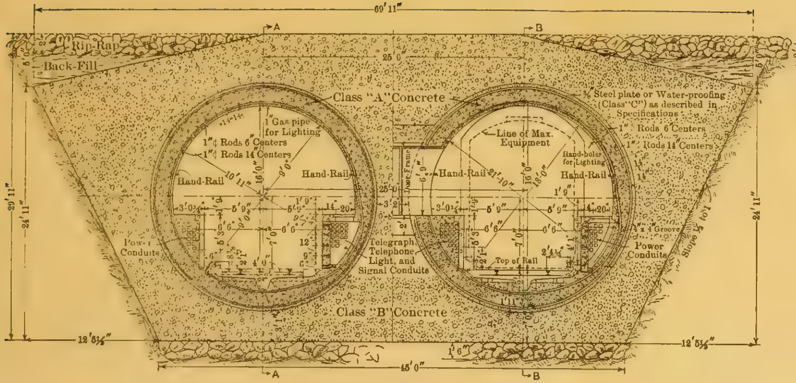
"Design *C* is practically the same as Design *A*, with the exception of the details shown on the plan, which prescribe a certain style of steel form and arrangement of reinforcement that differ from the arrangement shown on the plan for Design *A*."

The specifications for Design *B* further required the joints to be "made at the connection of the tubes so as to insure water-tightness and an equality of strength with the remaining portions of the tube, so that the joint will not be an element of weakness in the structure, and will be fully as strong as any portion thereof."

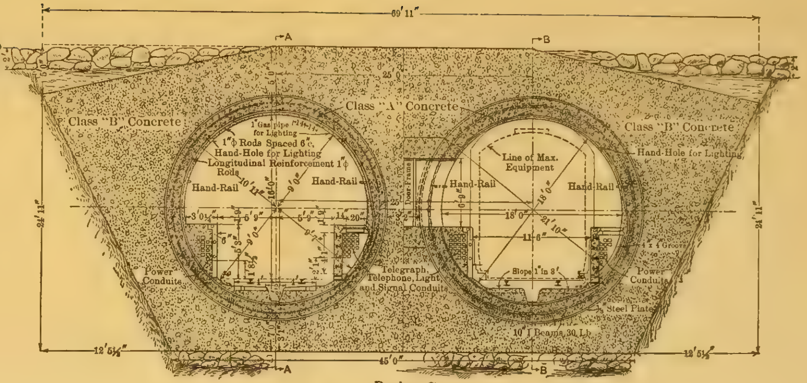
Some of the considerations and objections brought out by a study of these designs were as follows:

Design A.—This design, it will be noticed by reference to Plate CLX, contemplated filling the whole trench with concrete surrounding a series of cores or forms, and forming a kind of working chamber, inside of which the tunnel structure proper was to be built of reinforced concrete. The cores or forms might be of wood or steel, and were to remain in place permanently if of steel. A small air pressure was thought necessary, especially if the forms were to be of a temporary nature. The slopes of the trench, as shown, were ½ : 1.

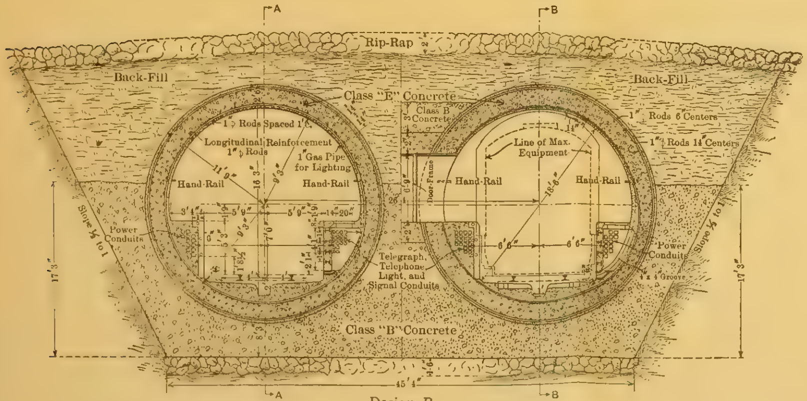
The writer came to the conclusion that this design was impracticable of execution. Depositing concrete as proposed in an open trench under water would have resulted in a very poor and unsatisfactory product, judging from such rather limited experience in that respect as the writer had had at that time. The experience subsequently gained has amply demonstrated this. It was evident, therefore, that the use of compressed air would be necessary, and that it would have to be at a pressure equal to the full hydrostatic head at the bottom of the tunnel, or about 30 lb. per sq. in. Later, this pressure was actually found to exist, as stated in the paper, even with the excellent grade of concrete obtained, which would have been absolutely impossible of attainment in Design *A*. Such a pressure would have produced a resultant internal tension in the concrete at the roof, which in all probability would have caused disastrous "blow-outs."



Design *A*



Design *C*



Design *B*

COMPARISON OF DESIGNS *A*, *B*, AND *C*.
DETROIT RIVER TUNNEL

About the only practicable way would have been to place the concrete in bags, which process would have been both slow and expensive, on account of the necessity of using divers in placing them. If deposited by tremie or bucket, the concrete would have flowed lengthwise of the trench, permitting the water to cut out more or less of the cement. Difficulties would have been encountered in forcing the concrete under the forms, as it would naturally move along the line of least resistance, which would be lengthwise of the trench. Mr. Hoff.

A great objection to Design *A* was the indefinite and excessive quantity of concrete required to fill the trench. No reliance could be placed on the clay standing at a slope of $\frac{1}{2}:1$, the probability being that 1:1 would be about the best that could be secured. As demonstrated afterward, the actual slope varied from 1:1 to $1\frac{1}{2}:1$, the average being nearer the latter than the former. In addition there was the question of how close to the actual line it would be possible to dredge—perhaps within 5 or perhaps even 10 ft.—at any rate, again greatly adding to the quantity of exterior concrete. A subsequent computation, based on the actual dredging done, showed that at least 80 000 cu. yd., and more probably 100 000 cu. yd. (or even more), would have been required in addition to the quantity actually used in the adopted design (about 102 000 cu. yd.). This would have represented from $500 000 to $600 000 in money, and at least another year in time.

Design C.—This was open to the same objections as Design *A*, with respect to the depositing and the quantity of exterior concrete. It had the advantage of safety, however, as it involved the definite use of a steel shell for an inner and permanent form, which was reinforced with 10-in. curved I-beams, 5 ft. from center to center and riveted to the shell along its circumference, thus making it of sufficient strength to resist the water pressure. The estimated cost of the steelwork in this design was quite high, and it would have been difficult to place the interior concrete on account of the I-beams.

Design B.—This design contemplated sinking in the trench sections of the completed tunnel of reinforced concrete, similar in construction to the interior structure built inside the exterior concrete of Design *A*, but 30 in. thick, instead of 23 in. When in position in the trench, the lower half was to be embedded in concrete and the upper half covered with back-filling. This design would probably have been more economical than either *A* or *C*, but it offered these difficulties: The tunnel would probably have to be built in 50-ft. or 100-ft. sections, in order that they might not break in two in handling. Their weight per foot would have been more than ten times the weight of the tubes of the adopted design while afloat, with a much less power of resistance in case of plunging during sinking. The concrete when submerged would have absorbed water, making the weight of the tubes variable

Mr. Hoff. and thus adding to the difficulty of sinking. There would have been a great number of extremely difficult and expensive joints, and it would have been especially difficult to make them of equal strength with the tubes. Considerable time would have been required to build the sections; if built in 100-ft. lengths, 52 would have been required, and each would have needed at least 2 months for building and hardening. Even by constructing a plant to build four at a time, 26 months would have been required, including both winter and summer. There would have been some difficulty in placing the concrete under the tubes in the trench, in order to give them a good bed. Probably this could have been done best by the use of bags and divers.

The result of the foregoing analysis was the gradual development of the design submitted by the writer, which, together with the specifications and the accompanying proposal, was accepted by the Board of Engineers, and according to which the tunnel was built, the contractors assuming full responsibility for its success or failure.

The first object sought in working out this design was the elimination of compressed air, with its attendant cost and restrictions in prosecuting the work. Nevertheless, as a matter of prudence, it was thought well to be prepared to use it, in case the exterior concrete, contrary to expectations, should prove a failure. The initial step toward the accomplishment of this was a tube of steel of sufficient strength in itself, or in connection with the exterior concrete, to resist the water pressure and effectively to prevent its ingress into the tunnel, thus saving the cost of water-proofing. This shell, at the same time, would constitute an inner form for the exterior concrete; if lined with concrete, the shell could be made quite thin; if not lined, it would naturally be made thicker.

Prudence required that, in this case at least, being the first time the scheme was tried, a substantial inner lining be provided, in case the quality of the exterior concrete should prove disappointing. Assuming this concrete to be of good quality (which was so thoroughly established later during construction), the steel shell need only be of sufficient strength to resist the hydrostatic pressure, assuming the concrete to hold the shell firmly in place and prevent buckling. It was proportioned on this assumption.

The next object sought was to reduce the exterior concrete to a definite quantity—the minimum required—without filling up the whole trench, thus saving a large item of cost. A little study and a few calculations soon demonstrated that this minimum would be the quantity necessary to overcome the buoyancy of the mass in the trench, when the tubes were unwatered, and prevent them from floating up again. This condition would obtain with the exterior concrete formed in the shape of a rectangle of such dimensions as to give a minimum thickness of 3 ft. around the steel tubes at the top, bottom, and sides,

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the distance between the tubes also being 3 ft. In order to secure this result, it would be necessary to have an exterior form for confining the concrete, preferably of wood, to make it as inexpensive as possible. Portable forms of wood or steel were considered, but the idea was soon abandoned, as very little, if anything, would be saved in the cost, and the operations would have been more complicated.

The next step was to secure this outer form to the steel shell or inner form. Wooden braces were first thought of (to save expense), but were abandoned because they would be buried permanently in the concrete. A solid steel plate seemed to be the proper solution, as this would divide the tubes longitudinally into compartments, which could be filled with concrete, one at a time. This plate need be of the smallest thickness practicable, and, of course, would require to have its edges stiffened with angle irons, the wooden form or sheeting being bolted to those on the sides. Thus the diaphragms were developed, together with the pocket or compartment principle, to which, in the writer's judgment, the success attained at Detroit is to be attributed. The concrete was discharged through the tremies under a head; its lateral flow was confined to the exterior sides of the compartment, and thus it was forced under the steel tubes, affording them a reliable and satisfactory bearing. The steel diaphragms were 12 ft. apart, thus greatly stiffening the steel tubes; and the angle iron flanges along the edges obtained a good grip on the concrete, binding the whole together in one composite structure of more than sufficient strength to resist all external or internal forces to which it might be exposed.

This design, as adopted and carried out, has frequently been referred to as a "Modification" of Design *A*. By a comparison of the designs, any one interested can form his own judgment as to what extent it is a modification of Design *A* or an original and independent design.

Details of Design.—As previously stated, the steel shell was proportioned to resist the full hydrostatic pressure, thus assuming that the water would penetrate the exterior concrete, but that the latter would be of sufficient strength to prevent deformation of the shell. This was made of $\frac{3}{8}$-in. plate, with a maximum stress of 9 400 lb. per sq. in. gross, or 13 200 lb. net (deducting for rivet holes). The rivets were $\frac{3}{4}$ in. in diameter, 3 in. apart, and arranged in two rows, also 3 in. apart. Each rivet sustained a maximum shear of 6 200 lb.

The length of the steel tubes was fixed at 262.5 ft., being one-tenth of the original length of the subaqueous tunnel (2 625 ft.), so that, when down in the trench and resting only on the platform supports at the ends, in case of an accident which might cause the air cylinders to be filled with water, the tubes would span across from end to end without collapsing, subjected to an extreme fiber stress of 16 000 lb. per sq. in. This contingency, however, never arose.

Mr. Hoff. The thickness of the wooden sheeting was determined on the assumption that the concrete could not possibly exert a greater pressure on it than its weight in water (taken at 75 lb. per cu. ft.) multiplied by its height in the pocket, thus acting as a liquid, and that, if this pressure were kept just below the breaking strength of the timber, the sheeting would be safe. The extreme fiber stress varied from 5 735 lb. per sq. in. on the 6-in. planks at the bottom to 2 670 lb. on the 4-in. planks 6 ft. from the top. No planks were ever broken, notwithstanding the fact that the cheapest lumber obtainable was used for this purpose.

The bulkheads at the ends of the tubes were placed at the first diaphragm from the end, so as to obtain a rigid frame against which to caulk along their circumference. They were made of yellow pine, which would swell less than any other wood when soaked. The timber in the full-pressure bulkheads was subject to an extreme fiber stress of 1 600 lb. per sq. in. The total pressure on each of the latter, when the tubes were unwatered, was 775 tons, which was distributed as evenly as possible over the steel shell by using suitable braces reaching back to the next diaphragms.

The semi-bulkheads for the first section were made 7 ft. deep at the center, but this was not quite sufficient, and, for the remaining sections, they were made 9 ft. deep, which gave satisfactory results. These semi-bulkheads were introduced as a result of some experimental tests, made by the writer with a tin model of a tube section, in order to study the possible tendency to plunge during the process of sinking. It was found that this tendency would not manifest itself until the tubes were about two-thirds or three-fourths filled with water; the object of the semi-bulkheads was to trap the air at this stage, in case one end should fill ahead of the other, and thus check it until the other end caught up.

One peculiar feature of this method of tunneling is that the load on the bottom of the trench during construction will be as great as, or greater than, the maximum load of the completed tunnel when in use. In other words, the weight of the water inside the tubes is equal to, or greater than, the weight of the concrete lining and the live load. At Detroit the load on the bottom before unwatering was 1 410 lb. per sq. ft., and the load of the completed tunnel plus a live load of 6 000 lb. per lin. ft. of each track was 1 400 lb. per sq. ft.

As stated previously, the quantity of exterior concrete needed was just enough to overcome the buoyancy of the whole mass when the tubes were pumped out. Owing to uncertainty as to the quality of this concrete, especially at the top of the tubes, where the water flowing over the concrete might be expected to wash out some of the cement before it had set, the thickness above the tubes was increased by 1½ ft., making the minimum 4 ft. 6 in. The same quantity of concrete was deducted at the sides of the tubes by sloping the lower 11 ft. 4 in. at the rate of ½ : 1, as shown on the plans. Mr. Hoff.

Adding the concrete on top was an unnecessary precaution, as its quality, to the very top surface, proved to be so good. It would have been better not to have sloped the sides, but to have retained the straight rectangular shape of the exterior concrete, and to have made the thickness on top about 6 in. greater than at the sides, on account of the top surface being likely to run uneven to that extent.

When the tubes were unwatered, the relation of weight to buoyancy was as follows:

Weight of steel shell, per lin. ft.	4 200 lb.
Weight of exterior concrete, at 140 lb. per cu. ft. (excluding that below the diaphragms)	107 600 "
Total weight	111 800 lb.
Displacement	101 500 "
Excess weight per linear foot preventing the tubes from floating up	10 300 lb.

Of the greatest importance was the problem of lowering the tubes into the trench and keeping them always under absolute control. To this end the four air cylinders were devised, and served the purpose most successfully. They were of such size as to have a combined buoyancy, when submerged, slightly in excess of that required to hold a tunnel section in suspension. The total buoyancy of the four air cylinders was 609 tons, and the total weight of a submerged tunnel section was 516 tons, leaving an excess of 93 tons, or 23¼ tons for each cylinder; accordingly, the corresponding quantity of water, would have to be admitted to the center or adjustment compartment of each, in order to admit of lowering the mass into the trench. They were placed in wooden cradles on top of the diaphragms and attached by flat straps to the third and the sixth diaphragms from the ends; these straps passed over the cylinders and had turnbuckles for tightening, and links which engaged pins through the diaphragms, which were suitably reinforced for the purpose, so that divers could readily disconnect the cylinders when needed for sinking the next section. A set of timber braces was placed longitudinally between the cylinders, and the tubes were designed to hold them firmly in place, in case the tubes should take a plunge while being filled. The straps were placed around the cylinders at such points as to produce a minimum longitudinal bending, to resist which a riveted lattice truss was placed vertically in the center line of each cylinder and made a part of the shell.

These air cylinders also served another purpose, namely, as compressed air receivers. Immediately before sinking they were pumped

Mr. Hoff. full of compressed air (under a pressure of from 30 to 40 lb.) and connected with the 2-in. air valves at the top of the end bulkheads by a rubber hose having a cut-off valve. If the air trapped between the semi-bulkheads and the end bulkheads escaped, on account of leaks, it could be replaced from the air cylinders by simply turning the valve and admitting as much as would be necessary to check or even raise the end which was going down too fast.

When the tubes had been landed in the trench and concrete had been placed under them at the ends and at least at one point in the middle, so as to give them not less than three points of support, the air cylinders could be released. This was done by first filling them with water, which caused the weight of the tubes to be gradually transferred from the cylinders above to the concrete below. When filled, the stresses in the attachments were neutralized and the cylinders were easily disconnected by divers and brought to the surface, either by forcing air into the center compartment or raising them by derricks. Both methods were used.

A word may be said on the subject of holding the tubes against the current during sinking. The tubes and air cylinders when submerged occupied one-eleventh of the area of the river cross-section; accordingly they dammed the river to that extent and increased correspondingly the velocity of the current. This was ordinarily 3.4 ft. per sec. at its swiftest, and was probably increased to 3.7 ft. while the tubes were submerged and until they were landed in the trench. It was estimated, using the following formula, that the pressure against a tube section and its air cylinders would amount to approximately 80 tons, and the anchorage cables and tackle were proportioned accordingly. That this assumption was very nearly correct was unexpectedly proven one day, when the superintendent tried a 1¾-in. line in the blocks instead of a 2-in. line, because the latter worked too hard in the sheaves. The 1¾-in. line snapped, while the larger one held; the breaking strength of the former was about 70 tons and of the latter about 90 tons, both being eight-part lines (running over four sheave blocks). The resistance, r, in pounds per linear foot $= \xi \frac{w}{g} d \frac{v^2}{2}$, in which $w =$ the weight of the fluid, in pounds per cubic foot; $d =$ the diameter, in feet; and $v =$ the velocity of the current, in feet per second. $\xi = 1.3$ for flat surfaces, and 0.7 for cylindrical ones.

The plans originally contemplated the use of anchors of cyclopean concrete planted in the bed of the river, to which the anchor lines were to be fastened. The superintendent entertained the idea, however, that ordinary ship anchors would suit the purpose equally well; they were tried, but failed utterly. For the third tube sections as many as twelve such anchors were laid out and connected up with lines, but they slipped, and the tube section swung down stream.

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Thereafter the method described in the paper was used (planting a concrete slab in a hole dredged out in the river bottom and filling clay on top), and proved very satisfactory.

The time required for taking a section from its moorings, placing it in position over the trench, attaching it to the anchor lines, filling the tubes, adjusting the air cylinders, lowering the section to the bottom of the trench and pulling it home, so that the keys could be inserted in the pilot pins, thus locking the sections together (when the tubes would be considered safe and beyond any great risk), took from, say, 8 A. M. until 8 or 9 P. M., after the first two or three sections had been sunk. The lining up of the tubes at the outer end, and the bolting up of the flange connections, could then be commenced the next day. The latter required generally two days, there being about 50 bolts to a joint, or 100 bolts to a section.

A great deal could be said on the subject of placing the exterior concrete around the tubes, but, as this discussion is already too long, the writer will simply refer any one interested to his paper, "Laying Concrete Under Water—Detroit River Tunnel."* It might be stated, however, that a new principle was established at Detroit, with respect to placing concrete under water, namely, that by means of the tremie, properly constructed and operated, concrete may be deposited so that the great mass of it will not come in contact with the water at all, after the first surface of concrete has been formed. This is accomplished by mixing it so wet that the mouth of the tremie at all times is buried in it, thus sealing the end of the pipe and controlling the flow by raising or lowering the tremie in the concrete, and by confining its lateral flow in compartments which are filled one at a time, the concrete all the time seeking its level within the compartment.

For a length of about 1 000 ft. in the middle of the river the bottom of the trench became very soft after it had been excavated, although the digging had been quite hard. It was difficult to assign any reason for this, except the probable existence of several springs in the rock underlying the clay, which, when most of the latter had been removed, would force themselves through the remainder of it, converting it into a puddle. The existence of such springs had been discovered when the borings were made, the water in the casings often rising higher than the river level. To secure a proper foundation for the tubes where this occurred, the wooden sheeting was run down straight, thus increasing the width of the base by about 11 ft. The tremies were then lowered as far as they would go through the soft clay, and, under their own weight (from 7 to 8 tons when filled with concrete), they would generally go down to within 1 or 2 ft. of the rock bottom at a depth of from 85 to 90 ft. below the surface of the river. A little

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* *Proceedings*, National Association of Cement Users, Vol. 6, 1910, p, 180; also in *Engineering News*, March 17th, 1910.

Mr. Hoff. extra force was used to put them down as far as possible, and concrete was then deposited until it reached the underside of the diaphragms. In this manner, judging from the number of cubic yards deposited, a series of piers, 6 ft. in diameter, was built up under the tubes, two to a pocket longitudinally of the tunnel, and three rows, one for each tremie; that is, there was one row under the center wall and one under each of the side-walls of the tunnel.

Two methods for unwatering the tubes were considered, namely, by pumps or by air; the latter, after some study, was abandoned. The air pressure required would have had to be at least equal to the hydrostatic pressure at the bottom of the tunnel, or say 30 lb. per sq. in.; this air pressure, of course, would have been uniform at all points inside the tube. The hydrostatic pressure, however, would have varied with the depth; it would have been 20 lb. at the top of the bulkheads and 25 lb. at the center; thus the inside air pressure at these points would have been 10 and 5 lb. in excess of the water pressure outside, which would have tended to blow out the oakum caulking between the timbers. The bulkheads would have had to be designed to resist pressure from the inside as well as the outside. It may be of interest to note that the pumps (8-in. vertical, each having a capacity of 5 000 gal. per min.) were installed in the first section before it was launched, and remained submerged more than 7 months before they were started in order to pump out the first section. Nevertheless, there was not the slightest difficulty in starting them. The unwatering, as a rule, required 3 hours per tube in a section, or 6 hours for two adjoining tubes, when the full-pressure bulkheads were placed in every other section, which was generally the case.

On the subject of the exterior lining of concrete, little need be said. This lining was made thicker than necessary, as this was the first time this new method was tried, and the quality of the exterior concrete was unknown when the design was made. The thickness was 20 in., or only 3 in. less than required for the tunnel proper of Designs *A* and *C*. On the other hand, the heavy reinforcement, both circumferential and longitudinal, required in these designs, was unnecessary, and only a few longitudinal rods (spaced about 1½ ft. apart) were placed near the inner surface of the concrete to assist in preventing cracks which might be caused by temperature changes or in the setting up and drying out of the concrete. The lining for Section No. 1 was not completed until 21 months after its unwatering; for the other sections, the time varied from 4 to 12 months, and averaged about 8 months. If necessary in order to save expense, such a tunnel might remain unlined, in which case the steel shell ought to be made a trifle heavier (by, say, ⅛ in.) than required to resist the hydrostatic pressure. Generally, it is preferable to use, say, a 12-in. lining for a tunnel of the size at Detroit.

One object in developing the adopted design was to reduce the use of divers to a minimum. Diving is expensive work, and frequently unreliable. The only physical labor performed by divers was the temporary attaching of the steel tubes to the grillages in the trench, the bolting up of the joints of the tube sections, and the disconnecting of the air cylinders. In other respects, divers were only used as "eyes to see with," that is, as inspectors to report conditions. The total cost of diving at Detroit was only about one-half of 1% of the total cost of the river tunnel. Mr. Hoff.

At the outset, apprehension was felt by some that trouble might be caused by the trench silting up; such fears were groundless, however. Although part of the trench remained open for almost a year, there was no silting up by material carried in suspension by the river. Section No. 2 was in direct line with the flow of sewage discharged from a large intercepting sewer above the tunnel site. Some of this sewage found its way into the trench, but was easily pumped out. When Section No. 1 was unwatered, it was found that gas from this sewage had been formed inside the tubes and had to be drawn out; some of it remained, however, being pocketed between the outer bulkhead and the semi-bulkhead next to it; this gas exploded when a workman unwittingly struck a match, but no damage was done. In fact, the construction of the whole river section was singularly free from accidents, not a single fatality occurring in connection with the river work—a striking contrast to the general experience when compressed air and shields are used. It may be of interest to note that three of the largest concerns in the country writing Employers' Liability Insurance offered to give protection at about one-third the rate they charged for tunnel work done under compressed air.

One feature of this method of subaqueous tunnel construction which is of great advantage is the small labor cost, as compared with the compressed air and shield method. On the other hand, the aggregate cost of the materials will generally be larger, but not enough to overbalance the labor cost; the result is a stronger and more durable construction, certainly a desirable quality in a subaqueous tunnel. If the bottom is soft, there is nothing to prevent piles being driven to a level below the diaphragms, or using other means for producing a satisfactory foundation.

At Detroit this method affected a saving of about $2 000 000 over a shield-driven tunnel with compressed air, and to this should be added the capitalized saving in annual cost of operation on account of the tunnel being placed some 15 ft. higher, thus reducing by this amount the vertical lift of the tonnage passing through. This distance of 15 ft. meant a saving of 1 000 ft. of approach tunnel on the Canadian side, having a maximum gradient of 1.5%, and 750 ft. on the American side, with a gradient of 2 per cent.

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Another great advantage of this method is the fact that for long tunnels work may be started at several points, and tubes may be sunk, working both ways, thus greatly reducing the time of construction.

Before leaving the subject of the subaqueous tunnel, attention must be called to a matter of great importance: The hydrostatic pressure inside the steel tubes must at all times be maintained equal to that outside until the exterior concrete has been placed. This is readily done by keeping the inlet valves open, or keeping the air escapes back of the semi-bulkheads open until the last pocket has been filled with concrete, thus providing direct communication between the water inside and the water outside the tubes. If this precaution is not taken, the risk is run, in unwatering an adjacent section which has been completed, that water may leak through the full-pressure bulkhead between the two sections if not absolutely tight, and thereby expose the steel shell, where not yet encased in concrete, to the full hydrostatic pressure from the outside without a corresponding equalizing pressure inside, thus causing it to fail by deformation. A temporary vacuum might even be produced, thus exposing the shell to the atmospheric pressure as well, in which case it would surely collapse. As soon as the exterior concrete is placed there can be no danger of this, and, in any event, the possibility of such an occurrence can very easily be prevented.

Approach Tunnel.—The Detroit River Tunnel presents the anomaly of having the approach tunnels wholly or in part driven by shields and compressed air and the subaqueous tunnel built without the use of it. This was due to the peculiar plastic quality of the blue clay, which at a depth of 25 to 30 ft. from the surface had a tendency to flow when opened up by shaft or drift, and, as a consequence, developed enormous pressures. Frequently this material has been termed a "swelling" clay, but this is a misnomer—it flows. In the drifts originally driven for the center wall on the Canadian side, the posts of the drift, consisting of 12 by 12-in. maple timbers, 8 ft. long, spaced 2 ft. apart, would break, while the caps, of the same dimensions and length, would hold. Assuming a pressure on the posts per square foot equal to the depth of the drift from the surface multiplied by the weight of the clay per cubic foot (about 140 lb.) a fiber stress of combined bending and compression would be developed amounting to about 7 000 lb. per sq. in., thus producing rupture. To resist this flowing tendency and partly counteract the resulting pressure, compressed air at about 15 lb. pressure was used.

On account of the design of the approach tunnels providing for a center wall, it was necessary to drive practically three tunnels; one for the purpose of constructing the center wall and one for each of the two tracks. It would have been much cheaper, and would have greatly

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simplified the operations, if the approach tunnels had been designed as two separate, circular tunnels, one for each track, so that each could have been driven by a circular shield.

After two years of constant effort and sacrifice of health to make this new and untried method of subaqueous tunneling a success, it was a source of the greatest regret to the writer that he was unable to remain with the tunnel and witness its completion; circumstances beyond his control made it necessary for him to retire from the contracting firm in October, 1908, after Section No. 6 had been sunk, and after practically all problems presenting themselves in connection with this work had been solved.

Since writing the foregoing the *Proceedings* of the Society for November have come to hand, in which Mr. Wilgus makes certain statements which are misleading and calculated to obscure the issue. In an attempt to make out a case and refute Mr. Gundersen's discussion, he publishes some personal letters between the writer and himself which have no bearing whatever on the question at issue.

It is greatly to be regretted that any one should use the publications of the Society for a personal attack. It having been made, however, the writer feels constrained to make the following statements, purely as a matter of self-defense:

Mr. Wilgus' letter to the writer was dated September 30th, 1905; the writer's reply was dated October 6th, 1905. Both letters had reference to Scheme *A*, which had previously been discussed between them, and which the writer, later, after a closer study, considered impracticable. The scheme developed afterward by the writer, and accepted by the Board, was submitted with the proposal on November 26th, 1906, nearly six months after the last of the above letters. This scheme comprised the diaphragms with the wooden sheeting bolted to the sides, thus providing the pocket arrangement, the joint with the pilot pins for connecting the tubes automatically, and the method of sinking the tubes by the use of the buoyancy cylinders. These features were no part of Scheme *A*, or *B*, or *C*, and neither Mr. Wilgus nor anybody else suggested any one of them to the writer. They form the principal claims of the patents mentioned by Mr. Gundersen.

With reference to the indemnification clause in the contract, as regards patents, the contractors requested that the Tunnel Company protect them against suits in case there were patents in existence covering the general idea of building a tunnel in a trench, which was the method proposed by the Board. It was learned, later, that there were no such patents in existence. On the other hand, the writer discovered that Mr. Wilgus had taken out a patent jointly with Mr. Carson, covering Scheme *A* (Patent No. 829 190, issued August 21st, 1906, application filed February 10th, 1906), which they had a perfect right to do.

Mr. Hoff. Patents being matter of public record, the writer will here quote from the introduction of this patent as follows:

> "During the past thirty-five years there have been schemes proposed for constructing subaqueous tunnels by placing at the bottom of the water both inner and outer molds and depositing between the same and entirely around the inner one cement concrete, which when set or hardened is to constitute the tunnel-walls desired. This proposed method we deem impracticable, for, as we have learned by experience, concrete deposited under and in contact with water usually results in a far poorer product than when made and allowed to set in air. It usually also has numerous voids and cannot prudently be relied upon to prevent too-rapid percolation of water through it. There have also been proposed various schemes for sinking tubes of metal or other material, which when joined together at the bottom of the water unite to form a subaqueous tunnel; but processes hitherto proposed of connecting such tubes with sufficient accuracy and water-tightness as to be suitable for passenger-tunnels are difficult and uncertain.
>
> "The object of our invention is to furnish a process of laying subaqueous tunnels by which the objections above referred to and others will be obviated."

What is described above as impracticable is precisely what was done at Detroit: Concrete was deposited between "inner and outer molds and entirely around the inner one," *i. e.,* the steel shell and the wooden sheeting; the tubes were sunk and joined together with both "accuracy and water-tightness."

Later, when the writer applied for patents on the pocket arrangement and other features of his design, the above patent was never even referred to by the Patent Office; and hence it is a fair inference that the Examiner did not think the two schemes had anything in common (except, of course, the trench, which was not patentable).

The writer had access to the patent files of Mr. Wilgus and Mr. Kinnear in February, 1907, but this was in connection with a different matter. Somebody had claimed infringements of his patent because the contractors' plans showed piles driven in the bottom of the trench for furnishing a temporary support for the ends and middle of the tubes. This ridiculous claim was abandoned, but it created quite a stir at the time.

Mr. Wilgus states that he had no knowledge of the writer's patents until about the time they were issued, in December, 1908. He has evidently forgotten the fact that the writer informed him about his (the writer's) intention to take out a patent before the application even was filed, and that he suggested to Mr. Wilgus to go halves with him on foreign patents. The consideration of this was postponed until the writer had retired from the contracting firm, when Mr. Wilgus, under date of November 27th, 1908, wrote to the writer requesting a conference on the "European patent situation," and again, in

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another letter, of December 28th, requesting another conference to "discuss the patent question." At this conference Mr. Wilgus proposed to the writer to form a holding company to which should be transferred the writer's two patents and the patent owned jointly by Mr. Wilgus and Mr. Carson. This, however, the writer could not see his way clear to agree to. Now these patents appear to be of no value, according to the last paragraph of Mr. Wilgus' discussion, in which he, constituting himself both judge and jury, so declares.

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PAPERS AND DISCUSSIONS

This Society is not responsible for any statement made or opinion expressed in its publications.

EXPERIMENTS ON THE FLOW OF WATER IN WOOD STAVE PIPES.

Discussion.*

By Messrs. Robert G. Dieck, Melvin L. Enger, J. L. Campbell, Rudolph Hering, and Gardner S. Williams.

Mr. Dieck.

Robert G. Dieck, M. Am. Soc. C. E. (by letter).—This paper is an important contribution to the subject of pipe gaugings. The great care which has evidently been taken in the author's investigations and the considerable range of the experiments, give peculiar emphasis to the results, while the direction of further experiments in this field is clearly indicated. The conditions surrounding the experiments were most favorable for close determinations of the friction factor, and the clear exposition of the case warrants careful and serious discussion.

The use of the Kutter formula in pipe design has always been questionable, even though its ease of application, in default of a more convenient formula, has commended it. The assumption of a value for n has always been an arbitrary one among hydraulic engineers; and on account of this indefiniteness, uniformity of results has never been possible. For wood stave pipe, values for this factor ranging from 0.009 to 0.012 have been assumed, but the information regarding it has been of such an insufficient nature that even a reasonable approximation to the truth has never been secured.

It is evident from the Sunnyside experiments that an adjustment in the ideas of hydraulicians on this point is bound to come, and that these experiments, even if found to be imperfect, will point the way to a more rational assumption of the factor, and perhaps be the means

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* This discussion (of the paper by E. A. Moritz, Assoc. M. Am. Soc. C. E., published in *Proceedings* for October, 1911, and presented at the meeting of December 6th, 1911), is printed in *Proceedings* in order that the views expressed may be brought before all members for further discussion.

In the *Proceedings* of this Society, the Papers and the Discussions on Papers will hereafter be printed so that each will commence on an odd-numbered page. This is done by special request, in order to enable members who wish to do so to separate the Papers and Discussions for filing under various engineering subjects.

Mr. Dieck.

of discovering a simpler and more elastic formula. A close analysis of the experimental results will show that the choice of a value for n is not such a simple matter as has heretofore been assumed, and that, if full credence is to be placed in the results of Mr. Moritz's experiments, this factor is far from being a constant under all conditions of flow. When the discharge varies, all other conditions being the same, the value of n also varies; hence, in its present form, the Kutter formula cannot be considered a true statement of conditions. The introduction of a variable n would undoubtedly complicate the matter, and, in all probability, would make the application of the formula to pipe design practically an impossibility. However, as in all ordinary design, extreme accuracy is neither sought nor expected, further complication of the already involved Kutter formula, by the insertion of a value of n with a variable exponent, seems to be unnecessary. Analysis of the experiments will show that generally the factor decreases with increase in velocity, though all the results are not uniform in this respect, and though the variations do not follow a well-defined law.

It is to be expected that inaccurate determinations of the observed quantities have been made, and that certain contingencies might be met better if the experiments were retraced. The manner of connecting the manometers, the presence of air in the pipes, eddies in the pipes, and other factors, have no doubt had effect on the work; therefore, a rigid comparison of results may be improper. From the paper it would seem that the method of computing the cross-sections of the pipes was not entirely proper, and certain anomalies might be removed if this feature of the work were again investigated. The author assumes that leakage has generally been negligible, but this assumption is open to doubt. The correction for temperature is generally so small that it may be neglected, and therefore its determination has only an academic value. Except where there are great differences between the temperature of the flowing water and that of the mercury columns, temperature corrections need not be applied. It might have been of peculiar interest, however, if record of the specific gravity of the flowing water had been made. Mr. Moritz assumes a constant reduction factor for the mercury of the gauges, but possibly there may be error in this. The author does not state that screens were inserted to remove floating matter, or that the pipes were blown off in advance of the experiments to remove sediment. It is suggested that floating matter in the neighborhood of the manometers may have affected the readings appreciably, and that deposits may have reduced the areas of the pipes under conditions of low velocity.

Considering now the experimental results in detail, a general increase in n for the 55$\frac{3}{4}$-in. pipe is noted in the series for 1910 over that for 1909. It might be expected that the interior surface of the

Mr. Dieck.

pipe would become smoother with use. This might appear to indicate that deposits had reduced the area, but the gradient of nearly 3% in the section casts some doubt on this objection, though the velocity in the series has never exceeded 4 ft. per sec. The average value of *n* is 0.01072 for the 1909 series and 0.01111 for that of 1910. The curves of variation are practically parallel.

The lack of data on the 22-in. pipe makes it difficult to draw reasonable inferences from the experiments, and it seems wiser to exclude from discussion the results from that pipe. The curve of variation, which is of entirely different character from the others, would seem to bear out the assertion that there are serious leaks in the pipe, for, with increase of head, *n* increases considerably. The allowance for leakage has been small, and has not been varied with altered conditions of flow.

With the exception of Test No. 8, the curve of variation of *n* for the 18-in. pipe follows a general downward tendency with increased velocity. The average of the eight tests gives *n* a value of 0.01074. The profile of this pipe is such as to make reasonable the assertion that deposits had some influence on the results. With the exception of some irregularities, and a drop in value in Test No. 7, of the series for 1909, the curve of variation in *n* is regular, that is, inversely with the velocity. The average value is 0.01117 for the series. In the series for 1910, with the exception of that for Test No. 6, the value of *n* remains practically uniform for all velocities, the average of the determinations being 0.01075. It will be noted that the value has decreased with the use of the pipe.

With the 12-in. pipe, the value of *n*, while following the general rule of variation, is considerably higher than for all the other pipes, even excluding the apparently abnormal result obtained from Test No. 3. Omitting this test, the average value is 0.01276. The author's explanation—that there may have been deposits—seems sound.

Both series for the 8-in. pipe show the general tendency of variation in *n*, but the decided lowering of value in the series for 1910 is most interesting. Mr. Moritz objects to an explanation of this on the score of deposits, but rather favors the opinion that there was choking by air in the first series. It is possible, however, that in the early condition of the pipe the interior surface was quite rough, and engaged considerable sediment, thus decreasing the cross-section and apparently increasing the friction factor. With use and the occurrence of high velocities, the interior roughness in all probability did decrease, and his contention, therefore, is not adequate. The average values are 0.0111 for the 1909 series, and 0.00953 for that of 1910.

On the other hand, with the 6-in. pipe, there has been small change in the value of *n* throughout the entire series, though this factor shows an increase with use. Otherwise, there is no change in the general

Mr. Dieck. rule. The average values are 0.01022 for the 1909 series, and 0.01027 for that of 1910.

The curve of variation for the 5-in. pipe shows considerable irregularity. The meager information regarding the pipe makes strict discussion difficult. Here velocities are very low, and deposits may have occurred; but it will be noted that with the lowest velocity the friction factor is smallest; therefore, some other explanation of the peculiar results must be sought.

The average value of n is 0.01058. The general rule of variation is applicable to the tests on the 4-in. pipe, though the variation curve is very steep. The average value of n (0.01111 for Tests Nos. 3 to 7, inclusive) would not lead to the belief that there was serious clogging from the growth noted. The small values obtained from Tests Nos. 1 and 2, however, may be taken as an indication that there was some deposit under low velocities, due in part to the presence of the growth.

Taking into consideration the entire group of experiments, it is reasonable to conclude:

1. That the value n for wood stave pipe, whether continuous or jointed, increases with decrease in velocity (or varies inversely with some power of the velocity), and that, for practical purposes, this value lies within the rather narrow limits of 0.0100 and 0.0110;
2. That greater regularity in the determinations is evident when the loss of head has been measured by mercury gauges;
3. That the assumption of an invariable reduction factor for the mercury of the gauges is not altogether proper;
4. That methods to reduce the quantity of air in the pipes and the quantity of silt entering do not seem to have been adopted;
5. That there is no great necessity for altering the Kutter formula.

Undoubtedly, the experiments should be continued, for a number of doubtful points would then be more clearly understood.

Mr. Enger. MELVIN L. ENGER, ESQ.* (by letter).—The following statements are supported by reliable experiments on the loss of head in pipes, when the critical velocity is exceeded:

1. The exponent, x, in the equation, $H = m\, V^x$ is an index of the smoothness of the interior surface of the pipe.
2. The value of x may be as low as 1.70 for very smooth, clean pipe, and as high as 2.00 for pipes with a very rough interior surface.
3. Under no condition will the value of x exceed 2.00.

If the last statement is correct, some error must have been made in the experiments with the 22-in. pipe. The writer has plotted to logarithmic scale, in Fig. 16, the results given in Table 3 for the 22-in.

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* Asst. Professor of Theoretical and Applied Mechanics, Univ. of Illinois.

Mr. Enger.

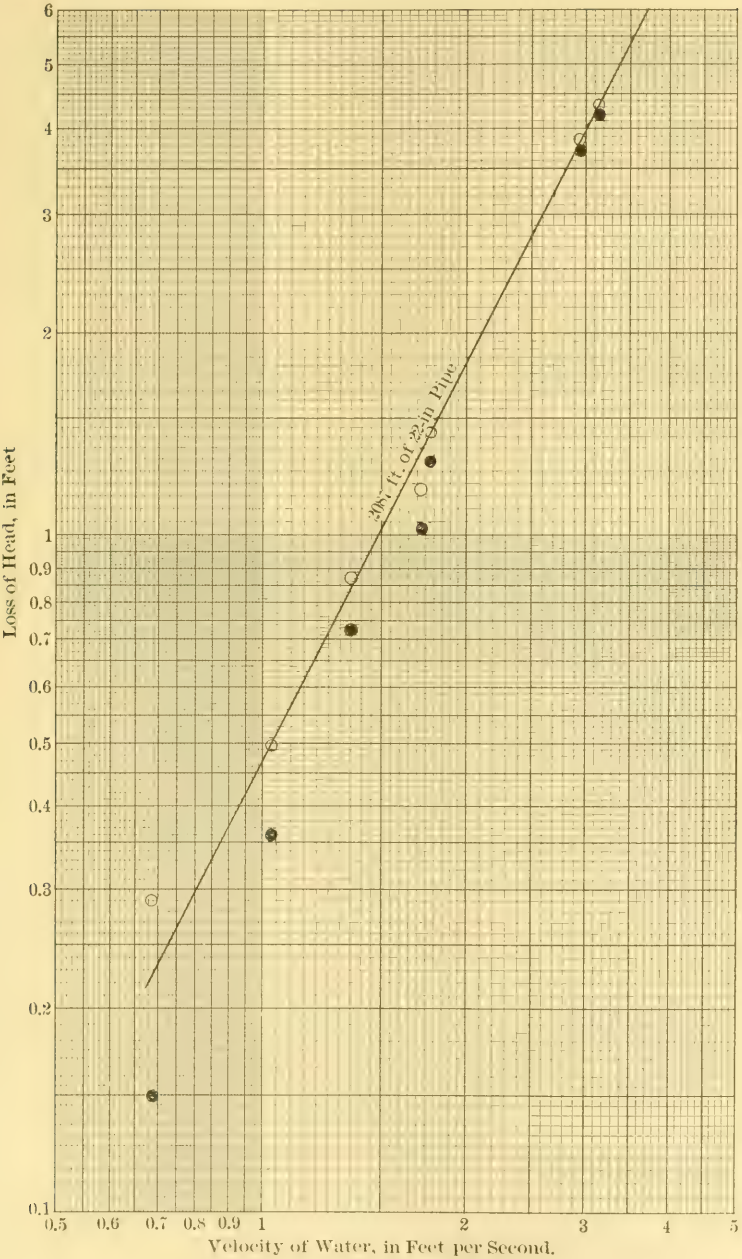

FIG. 16.

Mr. Enger. pipe. The values from this table are represented by solid circles, and these do not lie on a straight line. Adding 0.14 ft. to each value of the lost head puts five of the seven points on a straight line. Adding an amount larger than 0.14 makes the curve passing through these points concave upward; a smaller value makes the curve concave downward. The points obtained by adding 0.14 ft. are represented by open circles.

The amount (0.14 ft.) which it seems should be added to the loss of head may be explained as due to an error of that amount in the difference in the elevations of the zeros of the piezometers, or it may be due to an accumulation of air at a summit in the pipe line, or in one of the gauges.

When the correction is made, the equation for the 22-in. pipe becomes $H = 0.222 V^{1.95}$, instead of $H = 0.161 V^{2.15}$, as derived by the author.

Mr. npbell. J. L. Campbell, M. Am. Soc. C. E. (by letter).—In 1907 and 1908, the writer constructed, as a part of a pipe line system 135 miles long, 12 700 ft. of 10-in. and 48 000 ft. of 16-in. wood stave pipe, in the order named, from Bonito Creek to Nogal Reservoir, New Mexico.*

At the junction of the two pipes, an open stand-pipe, 6 in. in diameter, rises above the hydraulic grade line. The water surface elevations with maximum flow are as follows:

On the head of the 10-in. pipe..................	7 729.00
In the stand-pipe............................	7 305.00
In the outlet box at the reservoir...............	7 158.00

This gives gradients as follows:

For the 10-in. pipe....................	33.38+ per 1 000
" " 16-in. "	3.0625 " "

This pipe is like the jointed pipe described by the author, except that it is made of white pine, which takes a smoother surface in the planing mill than Oregon or Douglas fir.

The line was put in service in February, 1908. On March 10th and 31st, 1908, and in May, 1909, velocity measurements of flow were made. When the first two were made, there were 500 ft. of 10-in. pipe temporarily at the lower end of the 16-in. line, but this was replaced by 16-in. before the third measurement occurred.

In the first test, bran only was used. It flowed through the line from the head of the 10-in. pipe to the mouth of the 16-in. pipe, a distance of 60 700 ft., measured on the surface of the ground, in 3 hours 50 min., from which, the velocity and discharge were as follows:

Size of pipe.	Velocity.	Discharge.
10-in.	9.74 ft. per sec.	5.31 cu. ft. per sec.
16-in.	3.81 " "	5.32 " " " "

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* *Transactions*, Am. Soc. C. E., Vol. LXX, p. 164.

Mr. Campbell.

In the second test, two colors and bran were used at 15-min. intervals, and with an observer at a test valve at the stand-pipe in addition to the men at the head and the mouth of the line. The mean time, velocity and discharge were:

Size of pipe.	Time.	Velocity.	Discharge.
10-in.	0 hours 21.83 min.	9.70 ft. per sec.	5.29 cu. ft. per sec.
16-in.	3 “ 29.17 “	3.80 “ “ “	5.30 “ “ “ “
Entire line	3 “ 51. “		

In the third test, 15 months later, green aniline only was used three times at 30-min. intervals, with the following result:

Size of pipe.	Time.	Velocity.	Discharge.
10-in.	....	10.71 ft. per sec.	5.84 cu. ft. per sec.
16-in.	....	4.18 “ “ “	5.84 “ “ “ “
Entire line	3 hours 31 min.		

The discharges were estimated on the nominal diameters of the pipe. Subsequently, measurements showed that the actual diameters are 10⅛ in. and 16⅛ in., respectively, from which the corrected discharges are:

Size of pipe.	Test.	Discharge.
10-in.....	No. 1	5.44 cu. ft. per sec.
	No. 2	5.42 “ “ “ “
	No. 3	5.98 “ “ “ “
16-in.....	No. 1	5.40 “ “ “ “
	No. 2	5.39 “ “ “ “
	No. 3	5.93 “ “ “ “

Before the third test was made, a standard weir, 4 ft. long, without end contractions, was built at the outlet box, and measured the flow from the 16-in. line, giving a discharge of 5.88 cu. ft. per sec., as compared with 5.93 cu. ft. per sec., estimated from the measured velocity—a discrepancy of about 1 per cent.

For the following season of 1910 the highest recorded discharge over the weir was 5.88 cu. ft. per sec., but, for eleven consecutive days in May, 1911, this weir recorded a flow of 6.19 cu. ft. per sec., from which the maximum velocities appear to be:

Size of pipe.	Velocity.
10-in.	11.07 ft. per sec.
16-in.	4.37 “ “ “

With these velocities in Kutter's formula, *n* and *c* become:

Size of pipe.	*n*	*c*
10-in.	0.0089	132.
16-in.	0.0094	137.

This appears to indicate that the velocity may have some effect on the value of *n*.

Mr. Hering.

RUDOLPH HERING, M. AM. SOC. C. E. (by letter).—The author practically opens his paper with the apparently disheartening remarks that the tests quoted by him, and the best available regarding the flow

Mr. Hering. in wooden pipes, "are replete with inconsistencies." Later, he states: "any attempt to co-ordinate the results is apt to be discouraging" and "the results of previous experiments are so at variance with those described in this paper that it is doubtful whether any satisfactory balance of all available data can be made."

These opinions have been expressed rather frequently when new gaugings have been published, and it would almost seem as if engineers might be in error, either in some of their methods or in their expectations from them.

The published results of the gaugings quoted by the author, including his own, indicate that such gaugings were neither carelessly made nor could they be erroneous. In fact, they have usefully served the Profession in advising works which have been satisfactory.

Different results and varying conclusions are sometimes obtained simply because the details of the measurements as well as the conditions are not the same. Therefore one should hesitate to condemn the results unless one can compare very thoroughly all the details and justly pass upon their relative merits.

It has also seemed to the writer that the reason for some of these apparent inconsistencies was due to the manner in which the results were expressed; in other words, due to the particular formula used. The cause of all the trouble probably does not lie in the facts themselves, but in their interpretation. This question will be reverted to later.

The common criticism, that the so-called Kutter formula is too complicated, is not a good objection. The formula is hardly ever used in its original form, but by tables and diagrams. For small sections, the cause of the complication, namely, the influence of the slope on the value of the coefficient, *c,* in the fundamental Chezy formula, is entirely negligible, which reduces the Kutter formula to a very simple form, in fact, simpler than a number of other formulas.

Nor has the condemnation of the Kutter formula for the last thirty years prevented its extensive use, or even prevented the author from giving it a prominent place in his investigations. Comparing the results given by him in Table 11, for pipes from 4 to 55$\frac{3}{4}$ in. in diameter, it is almost astonishing to observe their comparative uniformity and consistency, when it is realized that this formula was neither devised from nor intended for such small pipes, or even for pipes at all, but only for open canals and rivers; and was based on gaugings on streams ranging in size from mill races up to the Mississippi River. Could such relative consistency have been possible if the framework of the formula had been very wrong?

The author says: "It has become generally recognized that Kutter's coefficients have no direct application to the flow of water in pipes," Mr. Hering.

and, as additional proof of the asserted fallacy of these coefficients, he selects four curves from his experiments, to show that n is a variable.

In 1888, when the writer translated Kutter's work, in conjunction with John C. Trautwine, Jr., Assoc. Am. Soc. C. E., he recognized, as well as did Mr. Kutter himself, almost at the outset, that n was not to be considered a precise and unvarying constant, although it was more nearly so than any other constant before proposed. It was for this reason, that the writer published in the translation, not Kutter's own tables with averages for n, but entirely new tables, in which the variations of n and not constant averages were shown, together with the other elements, as v, r, and s, so that the character and magnitude of this variation of n could be seen more plainly for all the gaugings available at that time. The coefficients given in the large table of the translation, therefore, are not fallacies, in the faintest degree. Every one was determined from actual gaugings, and appears merely in the dress—so to speak—of the Kutter formula, because the book happened to treat of that formula. Similar numerical values of coefficients representing the frictional and other resistances could be computed from the same gaugings in the dress of other formulas, such as Bazin's, Siedeck's, and others.

The only fallacy contained in the Kutter formula is the one that caused its complicated form. It was made necessary by the published formula of Humphreys and Abbot, which was supposed to represent the gaugings of the flow in the Mississippi River, which, later, was unfortunately found to be erroneous in some of the assumptions. Leaving out the complication caused by this fact, the Kutter formula, as already stated, becomes much simplified. Bazin's new formula, by omitting the deductions from the erroneous Humphreys and Abbot formula, is better than Kutter's.

All these formulas, however, are mere forms, and give identically the same practical results within the range of the gaugings if to them are applied coefficients which are based on these actual gaugings. If there was a table of coefficients for Bazin's and others for Siedeck's formula, for each case of size, shape, slope, and degree of roughness of wetted perimeter, then, if they were derived from actual gaugings within the same range, the same results would be obtained as with the Kutter formula with the Kutter coefficients.

The mean velocity of flow is caused by the hydraulic grade plane, and is controlled by all the resistances to the flow, one being the mean depth of water, and another the friction against the perimeter.

The latter cannot be exactly determined so as to be expressed by any formula. It can at best only be approximated and averaged. Differences in the results of different formulas are often due to the approximations alone. The exact determination of the resulting mean

Mr. Hering. velocity of flow is only possible by an accurate gauging of the case in question, and, for the practical application of any formula to a new case, the engineer should always consult actual gaugings, approximating as nearly as possible to the new case he has on hand.

The mean depth of water is expressed usually as "mean depth" for rivers and as "mean radius" for artificial channels. There is a difference, sometimes of a moment, between these expressions. The applications of formulas, therefore, should take due account of it.

$$\text{Mean Depth} = \frac{\text{Area}}{\text{Width}} = \frac{12}{4} = 3.0$$

$$\text{Mean Radius} = \frac{\text{Area}}{\text{Wet Perim.}} = \frac{12}{10} = 1.2$$

$$\text{Mean Depth} = \frac{\text{Area}}{\text{Width}} = \frac{12}{6} = 2.0$$

$$\text{Mean Radius} = \frac{\text{Area}}{\text{Wet Perim.}} = \frac{12}{10} = 1.2$$

$$\text{Mean Depth} = \frac{\text{Area}}{\text{Width}} = \frac{12.0}{3.91} = 3.07$$

$$\text{Mean Radius} = \frac{\text{Area}}{\text{Wet Perim.}} = \frac{12.}{12.3} = 0.98$$

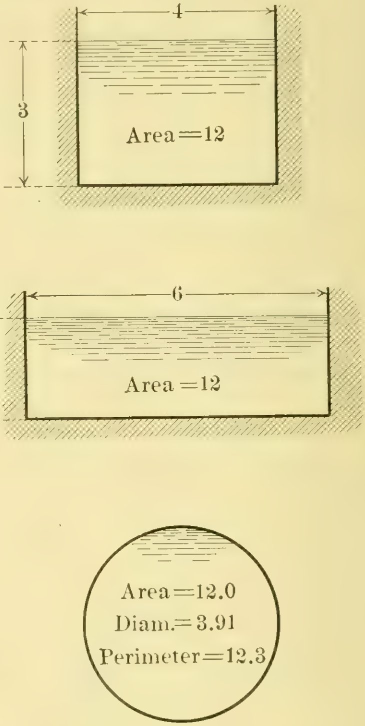

FIG. 17.

Take three artificial channels of the same sectional water area, and let one be circular and two rectangular, of which one is deep and the other shallow. The two different rectangular sections have identically the same "mean radius," but the deeper one has 50% greater "mean depth." The circular section of the same cross-sectional area has almost one-fourth less "mean radius" than either, and a "mean depth" 50% greater than that of the shallow rectangle.

All the older mean-velocity formulas take the mean radius as a constant, as well as the slope, and put all the variables into the coefficient, *c*, in the fundamental formula $v = c\sqrt{r\,s}$. This awkward

Mr. Hering.

feature, of itself, may bring trouble into the results, when comparing different cross-sections. The new formula of Siedeck, by introducing the shape as well as the size of the cross-section, obviates this feature, but it is relatively complicated, and professes to be applicable only to open channels.

On the other hand, in defence of the older practice, it must still be insisted that the friction of water against a firm surface, contrary to the friction of one solid against another, varies with area and not with pressure. Therefore, the area of friction, that is, the wetted perimeter, cannot be entirely ignored, which then makes the mean radius a better measure than the mean depth.

All these troubles and discouragements, as expressed by the author, from doubts, inconsistencies, apparent errors, and discrepancies in the formulas for the mean velocity of water, can be obviated with the use of almost any one of the best formulas by simply using it together with a table of experience data. Such a table should have an orderly classified enumeration of the results of actual and carefully made gaugings, so that, instead of by computations, the true relation can be obtained from it by inspection, and based on the following factors to be given in the table: velocity, cross-sectional area, surface width of channel, mean depth, mean radius, slope, and a numerical value for a coefficient representing the resistances computed from whatever formula may be the basis of the table, and giving as full a description as practicable of the character of the surface on which the water flows, of the horizontal configuration and length of the gauged channel, and mentioning any other causes which might have produced a velocity retardation or acceleration in the specific gaugings.

As gaugings covering almost every ordinary case are now available, a table such as suggested would dissipate the necessity for any formula, except to interpolate safely the conditions between those of known gaugings. For ordinary use, a few average coefficients, such as those now generally given, would suffice. For important cases, a sufficiently wide range of actual gaugings, all reduced to one and the same formula, should be used.

The writer, following these thoughts, made an attempt to construct such a table in 1888 in the translation of the book by Ganguillet and Kutter. The results in this table range from those obtained with small pipes to those of the Mississippi River, the table recording more than 1 250 actual gaugings. Since the date of publication, some of these gaugings have been found untrustworthy because carelessly or wrongly made, but a large number of new and excellent gaugings have also been made, among which may be mentioned those of the author and those quoted by him, to say nothing of a multitude of stream gaugings. If these were all added to such a table, including descrip-

Mr. Hering. tions of the kind mentioned, it seems that the hydraulic engineer should be supplied with sufficient practical information from actual gaugings to interpolate safely the desired coefficients for almost any special cases he might have on hand. All new gaugings, such as the author's, would find their place in such a table and add to the usefulness of the whole.

This proceeding, by using a formula merely as a frame for experience data, would be far safer than to use any formula alone for a new case, particularly when it has been obtained from a limited set of gaugings, unless the new case is an almost identical one.

Exponential formulas are readily obtained from any set of experiments, and the author has given one from his experiments. Yet it must not be forgotten that their range of application is limited to their specific source, and they rarely apply to other conditions. For this reason they are rarely heard of again. The *Transactions* of this Society contain a number of them which apply to the flow of water in pipes. They fitted their special cases admirably, as does the author's formula, but their usefulness and advantage generally end therewith.

Mr. Williams. GARDNER S. WILLIAMS, M. AM. SOC. C. E. (by letter).—The experiments presented by the author have in them elements of so much value as to warrant a request for some additional data. In the paper, the information regarding the measurement of the loss of head is quite complete, but this is only half the problem. For the determination of the volume of flow, one is compelled to accept the author's bare statements, as the data presented are quite deficient in those elements essential to an independent computation. The author's notion of determining the velocity of approach with a current meter does not seem to indicate a great familiarity with weir measurements, and there are many who do not consider the current meter sufficiently reliable for such investigations as these. On that account the writer would ask that the author supply, if possible, the following additional information:

1. A description of the head gauge and its location, and of the method of reading the head on the weir, as well as of determining the gauge reading which corresponds to the elevation of the weir crest;

2. The area and dimensions of the channel of approach, (*a*), at the transverse plane through the head gauge, and (*b*), at the weir;

3. The exact dimensions of the weir notch, the length of the end contractions, and the height of the weir crest above the bottom of the channel of approach;

4. A plan showing the arrangement and location of the weir and the gauge, and the channel of approach.

Mr. Williams.

It is rather surprising to find a hydraulic formula presented before this Society, in which one essential dimension is given in inches while the other dimensions are in feet. Our mechanical engineering friends are accustomed to jumbling up feet and inches in their formulas, but the civil engineer usually prides himself on sticking to a single unit wherever possible, and as all other pipe formulas in common use are in units of feet, it is to be regretted that the author has not put his in the same terms, to facilitate comparison, if for no other reason.

With the above information added, this paper is likely to become one of the very valuable contributions of recent years, as it covers a wide range of experiments in a hitherto unexplored field, and the writer would express his appreciation of the evidence of painstaking work on the part of the investigator, notwithstanding the foregoing criticism.

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AMERICAN SOCIETY OF CIVIL ENGINEERS
INSTITUTED 1852

PAPERS AND DISCUSSIONS

This Society is not responsible for any statement made or opinion expressed in its publications.

THE ST. CROIX RIVER BRIDGE.

Discussion.*

By C. M. Spofford, M. Am. Soc. C. E.

C. M. Spofford, M. Am. Soc. C. E. (by letter).—The author's effort to combine, in one structure, the advantages of two-hinged and three-hinged arches, by introducing a special friction joint in the central top chord, is worthy of special attention. Mr. Spofford.

The writer hopes that Mr. Turner will give a more detailed description of this device and of its operation under traffic.

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*This discussion (of the paper by C. A. P. Turner, M. Am. Soc. C. E., published in *Proceedings* for October, 1911, and presented at the meeting of December 6th, 1911), is printed in *Proceedings* in order that the views expressed may be brought before all members for further discussion.

In the *Proceedings* of this Society, the Papers and the Discussions on Papers will hereafter be printed so that each will commence on an odd-numbered page. This is done by special request, in order to enable members who wish to do so to separate the Papers and Discussions for filing under various engineering subjects.

MEMOIRS OF DECEASED MEMBERS.

NOTE.—Memoirs will be reproduced in the volumes of *Transactions*. Any information which will amplify the records as here printed, or correct any errors, should be forwarded to the Secretary prior to the final publication.

JOHN BOND ATKINSON, M. Am. Soc. C. E.*

DIED SEPTEMBER 21ST, 1911.

John Bond Atkinson was born on November 11th, 1840, on his father's farm near Mullica Hill, N. J. He was the eldest son of George T. and Elizabeth B. Atkinson, who were leading members of the Society of Friends.

In 1863 he was graduated from the Polytechnic College of Pennsylvania as a Bachelor of Civil Engineering. From 1863 until April, 1866, he was engaged with the Pennsylvania Railroad Company as Assistant Engineer of Construction and Maintenance of Way on the Philadelphia and Erie Railroad. His next work was on the west end of the Hoosac Tunnel, as Engineer and Superintendent for B. N. Farren, F. Am. Soc. C. E., the contractor. At this time he built 430 ft. of arching and masonry through the "soft rock," which work was undertaken and finished after the failure of the Commonwealth management to make progress. From April, 1869, until April, 1871, he was Engineer and builder of Turner's Falls Branch of the Vermont and Massachusetts Railroad. He also aided in the construction of Atlantic Avenue, Boston.

In April, 1871, Mr. Atkinson went to Kentucky and became Engineer and Manager for the St. Bernard Coal Company, later named the St. Bernard Mining Company. He held various positions in this company, and finally became President in 1894. For many years he was regarded as one of the best-informed coal men in America, and a mining engineer and executive officer of unsurpassed ability.

He took a leading part in exploiting Kentucky's mineral, forestry, and agricultural products and resources at the World's Columbian, the Atlanta, the Louisiana Purchase, and the Jamestown Expositions. He was Financial Director and President of the Kentucky Jamestown Exposition Commission.

In the first conference of Governors, in the White House, at Washington, in May, 1908, Mr. Atkinson took part, as one of the advisors of the Governor of Kentucky, the Hon. Augustus E. Willson, and presented one of the most important papers, "Forestry, as Related to Mining Interests." In Governor Willson's speech before that conference he paid Mr. Atkinson a high and deserved tribute, which appeared as follows in the official proceedings:

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*Memoir prepared by the Secretary from papers on file at the House of the Society.

> "The oratorical product of Kentucky ended some years ago, and we are now studying strictly utilitarian phases of life. We have in Kentucky many important coal companies. One of those has been managed in a manner that I think in its business management and in its own foresight presents a lesson of usefulness to every State. It was mentioned here that in the production of coal it had cost about seven lives for every million tons. This company, in ten years, has produced 1,100,000 tons, with only one life lost. (Applause.) This company bought great areas of land. A State Commissioner of a great State mentioned that they had planted a million young trees. This one company has alone planted on its land one million walnut trees and about a quarter of a million locusts, catalpa, and poplar or tulip trees, in the past few years. (Applause.) This information is from a paper, which I shall submit, by Mr. John B. Atkinson, one of my associates and advisors here, and a very useful one, who perhaps gave me the only good thought that Kentucky could bring here."

Mr. Atkinson was an authority on practical forestry, as he had been actively engaged in this work, in Hopkins County, Ky., for twenty years, in which time he had planted millions of young trees, many of them having been grown from seed.

Mr. Atkinson's first wife was Sarah Ann Black, of Mt. Holly, N. J., to whom he was married on May 23d, 1867. She died in November, 1900. They had two children, John, who died at Swarthmore College in 1883, while nearing the completion of his education, and Mary Newbold, who became the wife of Paul M. Moore and died in 1907, leaving two sons. On September 16th, 1903, Mr. Atkinson married again, his second wife being Anna Newbold Black. She and their little daughter, Nan, four years of age, survive him. Two brothers also survive, George C. Atkinson, of Earlington, Ky., who has been associated with him in business for forty years, and is now Vice-President of the St. Bernard Mining Company, and Warren Atkinson, a farmer, of Mullica Hill, N. J.

Mr. Atkinson was an indefatigable worker. He possessed an excellent physique, strong and commanding will power, quick and sure judgment, and great nervous energy. His interests were so broad and so diverse that the twenty-four hours of the day were all too short in which to compress the things he did for the business interests he represented, for his many employes, for his friends, and for humanity. He was always a strong supporter of schools and worthy educational movements. He influenced his company to give substantial help to the schools of Earlington, two modern, common graded and high school buildings having been built and equipped entirely at its expense. The company has also contributed annually to their support. He also aided many other educational and moral undertakings. One of his good works is represented by a school that bears his name, Atkinson College, at Madisonville, for the practical and industrial education of negro youth, which school he has largely supported. It was due to his influence that prohibition was established in Earlington in 1882, and his fighting determination has made it a fixed policy to this day.

Mr. Atkinson's health began to fail early in 1910. The disease from which he suffered, which rarely occurs, is known to medical science as lymphatic leukæmia, and has never been cured. He died on September 21st, 1911, at his country home, near Wrightstown, N. J., where he had spent the summers for several years. His body is buried in West Laurel Hill Cemetery, in Philadelphia.

Mr. Atkinson was elected a Member of the American Society of Civil Engineers on September 5th, 1877. He was also a member of the Engineers' Club of New York, of the Engineering Association of the South, of the American Association for the Advancement of Science, and of the Pendennis Club, of Louisville.

GEORGE JOSEPH BELL, M. Am. Soc. C. E.*

Died October 6th, 1911.

George Joseph Bell was born at Mossband Farm, at the head of the Solway Firth, in the Parish of Kirkandrews-on-Esk, Cumberland, England, on August 9th, 1835. He was educated at Croft House, Brampton. After leaving school he worked on large surveys for the Firth Commissioners, for commutation purposes, and on private estate surveys, with his uncle, the late Robert Bell, of The Nook, Irthington, Carlisle, England, who was a friend of George Stephenson and a well-known Civil Engineer and Surveyor.

After his uncle's death in 1856, Mr. Bell carried on the business until June, 1867, when he was appointed District County Surveyor of the Brampton Highway Board, his ancestors having lived and owned estates in the Brampton District for more than 600 years. While in this position he built many miles of new roads and stone bridges.

In 1871, Mr. Bell was elected District Surveyor of the Highway Board for the Isle of Axholme, in the Lindsey Division of Lincolnshire. He held this office until January, 1879, when he was appointed, from more than 200 applicants, County Surveyor and, later, County Surveyor and Bridge Master, for Cumberland, England, which position he held until his sudden death on October 6th, 1911—a period of 33 years. While in these positions Mr. Bell built, under the direction of the Highways and Bridges Committee, many miles of new roads through difficult country, laying out a new road over Sty Head Pass. He also designed and constructed a number of bridges.

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* Memoir prepared by the Secretary from information furnished by Percy Wilson, Esq., and from papers on file at the House of the Society.

Mr. Bell was an authority on oblique or skew arches for bridges, and published a work entitled "Segmental and Elliptical Oblique or Skew Arches," which has since become a standard on the subject. He constructed several bridges in Cumberland on this principle.

For some time prior to his death, Mr. Bell had been in failing health, but was able to attend to his duties, and it was a great shock when he was suddenly taken ill and died almost immediately while sitting in his chair in his office. He is survived by one son and two daughters.

Mr. Bell was a Member of the Institution of Civil Engineers, the County Surveyors' Society, of which he was a Past-President, the Municipal and County Engineers' Association, and the Sanitary Institute; he was also a Freemason.

Mr. Bell was elected an Associate Member of the American Society of Civil Engineers on November 2d, 1898, and a Member on October 1st, 1902.

HENRY PURDON BELL, M. Am. Soc. C. E.*

Died October 19th, 1910.

Henry Purdon Bell, son of Jacob and Helen (McCollough) Bell, was born at Rantalard, near Belfast, Ireland, on March 24th, 1841. He was educated at Preston Grammar School, in England, and from 1857 to 1862 served as an articled pupil to Sir Charles Lanyon, an Architect and Engineer, of Belfast. During this time Mr. Bell superintended the erection of buildings and railway works in the Counties of Down and Antrim, Ireland, involving many bridges—then of considerable size—and one tunnel, about half a mile long, on a sharp curve.

In 1862 he entered the Iron Bridge Works of Courtney and Stevens, of Dublin, Ireland, where he worked in the shop and also in the office. Here he studied bridge building, and was employed on the design of the Boyne Bridge, the first in which any attempt was made to calculate the stresses.

From 1863 to 1865 Mr. Bell was engaged on important irrigation projects for the Compania Iberia de Riegos, in Spain, under the late J. F. L. T. Bateman, Past-President, Inst. C. E., and George Higgins, M. Inst. C. E. This work included a tunnel about 3 miles long, which was worked from shafts and from horizontal drifts into the face of a cliff to the center line. One feature of this work was a heavy weir of ashlar masonry—curved in plan and cross-section—across the Henares River. Mr. Bell had sole charge of this work, and it was so well done that, although he was then only twenty-two years of age, he was appointed Resident Engineer on the surveys and construction of the Albalat drainage, near Castillon de la Plana, on the east coast of Spain. He also made surveys for several schemes for canals and the drainage of marshes.

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* Memoir prepared by the Secretary from notes furnished by C. D. Purdon, M. Am. Soc. C. E., and from papers on file at the House of the Society.

From 1865 to 1869 Mr. Bell was in business for himself in Belfast, for a short time in partnership with the late James F. McKinnon, but did no work of any magnitude. From 1869 to 1872, inclusive, he was an Assistant Engineer, for the Canadian Government, on the Intercolonial Railway, designing many of the bridges; and afterward Contractors' Engineer on the heaviest contract, a 20-mile section which was let for about $1 000 000.

For a part of 1873 he was engaged on the Girard Avenue Bridge, in Philadelphia, Pa., for the late T. C. Clarke, Past-President, Am. Soc. C. E., and then returned to Canada, where he became Division Engineer for the Dominion Government on the Rocky Mountain Division of the Canadian Pacific Railway. He remained on this Division until 1877, locating the line along the Fraser River and in the Cariboo country. He also located part of the line through Saskatchewan and Alberta.

In 1878 he served as Inspector on a bridge built for the Canada Central Railway by Charles Macdonald, Past-President, Am. Soc. C. E. From 1878 to 1881 he was again a Division Engineer on the Canadian Pacific Railway, this time on the Division extending from the Red River to Lake Superior, in which there was some heavy work involving rock cuttings and many bridges.

In the period from 1882 to 1884 Mr. Bell was in business in Winnipeg, Man., as an Engineer and Contractor, and built the substructure of the bridge over the Red River. This work comprised eight crib and pile foundation piers 35 ft. high, and was completed in three months. He also located the Saskatchewan Bridge and the approaches for 6 miles on each side for Mr. (afterward Sir William) Van Horne. During this period Mr. Bell also constructed part of the main line on the north shore of Lake Superior, and was Engineer for the Souris and Rocky Mountain Railway. Subsequently, he built part of the main line in the Rocky Mountains, and, in partnership with Mr. J. C. Patterson, afterward Lieutenant-Governor of Manitoba, constructed a section of the Esquimault and Nanaimo Railway.

Mr. Bell's next engineering work was in Chili, where he went as a representative of the North and South American Construction Company, which had received a large concession from the Government of that country. This concession was abandoned, later, but Mr. Bell remained in Chili for some years, building railroads and doing other work for the Government.

At the outbreak of the Balmaceda Revolution, he returned to Canada and took up the practice of his profession in Victoria, B. C. At the commencement of the surveys for the Georgian Bay Canal, he entered the employ of the Canadian Government, and designed many of the locks for that canal. He also prepared estimates of the cost of bridging Seymour Narrows, and made surveys and estimates for the work on the Trent Canal.

In the summer of 1910 Mr. Bell returned to Victoria on account of ill health. While bathing he was bitten by a fish, and died from blood poisoning.

Mr. Bell was married to Miss Agnes Blanchard, of Truro, N. S., who, with two sons and two daughters, survives him.

Mr. Bell was identified with all the important public works which did so much toward consolidating the independent provinces of Canada into one dominion. He was one of Canada's ablest and most resourceful engineers, but was of such a retiring disposition that he never attained the high position to which his ability and experience entitled him. He was highly esteemed by his employees and by all who knew him. His death is a loss, not only to the Profession in Canada, but to his many friends.

Mr. Bell was a Member of the Institution of Civil Engineers, of Great Britain, and was elected a Member of the American Society of Civil Engineers on June 4th, 1884.

WILLIAM JACKSON, M. Am. Soc. C. E.*

Died June 30th, 1910.

William Jackson, the son of Samuel and Mary Wright (Field) Jackson, was born in Brighton, Mass., on March 13th, 1848. He was educated at the public schools of Brighton and the Massachusetts Institute of Technology, where he took the full course with the Class of '68, but, on May 4th, 1868, having obtained an appointment on the staff of the City Engineer of Boston, Mass., he left the Institute without receiving his degree. At that time the Institute had not conferred any technology degrees, and it is possible that their value was not appreciated by the youth of twenty to whom an engineering position, with assured remuneration, may have seemed to be more attractive. Later in life, however, it was one of Mr. Jackson's regrets that he had not remained at college and taken his degree.

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* Memoir prepared by the Secretary from papers on file at the Society House, and from a memoir prepared for the *Technology Review* by Frederic H. Fay, M. Am. Soc. C. E.

His first work was on the construction of the Chestnut Hill Reservoir of the Boston Water-Works. In 1870 he became Engineer for the Town of Brighton, and also engaged in private practice until Brighton was annexed to Boston in 1873, when he again entered the office of the Boston City Engineer. During the next three years he was engaged on various work, including surveys for the introduction of water into Brighton and West Roxbury. From 1876 to 1885 he was Assistant Engineer on the Boston Main Drainage Works, a very important and difficult engineering undertaking.

In April, 1885, on the death of the City Engineer, the late Henry M. Wightman, M. Am. Soc. C. E., Mr. Jackson was appointed City Engineer, which position he occupied continuously until his death. In addition to his civic duties he was engaged in other important engineering works at various times. From 1887 to 1891 he was Chief Engineer for the Harvard Bridge Commissioners; from 1896 to 1900, Chief Engineer of Charlestown Bridge; and from 1898 until his death Chief Engineer for the Cambridge Bridge Commission. In the fall of 1898, in company with Edmund M. Wheelwright, Consulting Architect to the Cambridge Bridge Commission, he visited Europe in order to make a study of notable bridges preparatory to designing a monumental structure for Cambridge Bridge.

In 1891 and 1892 he was a member of the Boston Rapid Transit Commission; and a member of the Boston Statistics Commission from 1898 until his death. From 1902 to 1904 he was a member of the special commission on the abolition of grade crossings in Attleboro, Mass., and at his death had been for three years a member of commissions on the abolition of grade crossings in Foxboro, Westwood, Canton, Sharon, and Mansfield, Mass. He was Consulting Engineer to the Cambridge Water Board on the construction of the Hobbs Brook Conduit, in 1904; to the Shore Road Commission, in Brooklyn, N. Y., in 1896 and 1897; and to the Massachusetts Harbor and Land Commission on the Commonwealth Dock, South Boston, in 1899. He was also a member of the Approving Board appointed by the Legislature in 1907 to pass upon plans for the development and extension of the drainage systems of Boston. On several occasions, when a vacancy occurred at the head of another city department, Mr. Jackson was appointed to fill the position until a permanent head could be chosen.

Mr. Jackson was a man of high ideals and notable ability. He was modest and unassuming, eminently fair in his dealings with others, and faithful to every duty entrusted to him. To those who were in close association with him, he was a true friend and a lovable man. He won the regard and hearty support of his subordinates, and inspired confidence and respect in all who knew him. The following, from an editorial in the *Boston Herald,* is representative of the tribute paid to him by the press:

"The record of a life spent in the service of the public is in itself the eulogy of City Engineer William Jackson. From boyhood to death he was a public servant, filling one post of duty after another, meeting every responsibility, great or small, preferring public service to the greater emoluments which he might have earned in private enterprise. He was a patriot, even though he shouldered a tripod instead of a musket."

On April 27th, 1886, Mr. Jackson was married to Miss Mary Stuart MacCorry, of Boston. Mrs. Jackson died on March 27th, 1905. One son, William Stuart Jackson, survives.

At the time of his death Mr. Jackson was a member of the following organizations: Union, Art, and Technology Clubs, of Boston; Boston City Club, Point Shirley Club, Boston Driving Club, Strollers' Club of New York, Allston Golf Club, Commonwealth Riding Club, the Masonic Fraternity, Boston Chamber of Commerce, Technology Alumni Association, Society of Arts, American Association for the Advancement of Science, National Geographical Society, Bibliophile Society, National Municipal League, American Civic Alliance, American Civic Association, New England Historical and Genealogical Society, Bostonian Society, and the Society of Colonial Wars. He was also a member of the Boston Society of Civil Engineers, and of the New England Water Works Association.

Mr. Jackson was elected a Member of the American Society of Civil Engineers on September 3d, 1884, and served as a Member of the Board of Direction from 1902 to 1904.

BENJAMIN FRANKLIN MACKALL, M. Am. Soc. C. E.*

DIED APRIL 5TH, 1911.

Benjamin Franklin Mackall was born at Baltimore, Md., on April 5th, 1857. He was the son of General William W. Mackall, a distinguished officer of the United States and Confederate Armies. His mother was Miss Aminta Sorrel, a daughter of Francis Sorrel, of Savannah, Ga.

Mr. Mackall was graduated second in the Class of 1877 from the Virginia Military Institute. From 1877 to 1879 he read law and was Principal of the Harrisonburg Academy, Rockingham County, Va.

He began his professional career in 1880 as Principal Assistant Engineer on the construction of the New Inlet Dam, of the Cape Fear River Improvement, in North Carolina, under the direction of Mr. Henry Baker and the late William P. Craighill, Past-President, Am. Soc. C. E.

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* Memoir prepared by W. W. Gwathmey, Esq.

From 1885 to 1888 Mr. Mackall was engaged on location and as Resident Engineer on the construction of the Philadelphia Branch of the Baltimore and Ohio Railroad under Major H. T. Douglass, then Chief Engineer; and from 1888 to 1890 on location and as Division Engineer in charge of construction and tunnel work on the Shawnee and Muskingum River Railroad.

From 1891 to 1892, he was employed as Engineer in charge of the location and plans for the National Highway from Washington, D. C., to Mount Vernon, under the direction of Peter C. Hains, M. Am. Soc. C. E.

From 1892 to 1896, Mr. Mackall was engaged in private practice in Washington, D. C., as a member of the firm of Mackall and Clark. During this time he located and built the Glen Echo Railroad, the Tenallytown and Bethesda Railroad, and did other suburban engineering work.

From 1896 to 1899, he was employed as Engineer on the Chesapeake and Ohio Canal, and from 1898 to 1900, as Division Engineer, he had charge of the location of several lines of railway for the Seaboard Air Line Railroad.

In 1900 Mr. Mackall was promoted to the position of Assistant Chief Engineer of the Seaboard Air Line Railroad, with headquarters at Portsmouth, Va., and was actively engaged in both location and construction work during the formative years of this railway system.

In 1905 he resigned his position with the Seaboard Air Line Railroad and engaged in private practice as Consulting Engineer, in Norfolk, Va. He died at his old home, Langley, Va., on April 5th, 1911.

Mr. Mackall was never married. He was a man of retiring disposition and modest manner. His ability and efficiency, his strict integrity, and his high standing among his associates as an engineer, commanded the respect of those who knew him, both in professional and private life.

Mr. Mackall was elected a Member of the American Society of Civil Engineers on March 6th, 1901.

CHARLES ARTHUR MATCHAM, M. Am. Soc. C. E.*

Died September 22d, 1911.

Charles Arthur Matcham, son of Charles and Elizabeth Matcham, was born at Torquay, Devonshire, England, on January 15th, 1862. He was educated in the schools of Hambledon and Brighton, England.

In 1875, Mr. Matcham went to London and, while employed during the day, attended the evening classes at an engineering school. At the public examinations he won first prize and honorable mention for mechanical drawing and designing at the Royal Academy of South Kensington, England.

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*Memoir prepared by H. F. Bascom, M. Am. Soc. C. E.

From 1877 to 1880, he worked as a Mechanical Draftsman, in London. In 1880 he entered the employ of the International Bell Telephone Company, of New York, as Electrical Engineer. He remained in this position until 1881, during which time he designed and laid out construction work for telephone exchanges in Charleroi, Belgium, and in Riga, St. Petersburg, Warsaw, Moscow, and Odessa, Russia.

In the fall of 1881, Mr. Matcham came to the United States, and settled in Chicago, Ill., where he entered the employ of the Chicago Telephone Company, and was engaged in designing and building its exchanges. Later he removed to Memphis, Tenn., where he rebuilt the telephone exchange. In 1884, he came East to Allentown, Pa., and for several years managed the exchange there for the Pennsylvania Telephone Company.

In 1890 Mr. Matcham engaged in the business of cement manufacture, being associated with Mr. Thomas D. Whitaker in the Whitaker Cement Company, at Whitaker, N. J. He was General Superintendent of this plant until 1893, when it was sold to the Alpha Portland Cement Company, Mr. Matcham being retained as General Superintendent.

In 1897, with Colonel H. C. Trexler, he organized the Lehigh Portland Cement Company, of which he was Superintendent and General Manager. He built several mills for this company in Lehigh County, Pennsylvania, and contributed in no small degree to its prosperity.

In 1906 Mr. Matcham assisted in the organization of the Fuller Engineering Company, of Allentown, Pa., and became its President, a position which he retained until 1910. He was elected General Manager of the Allentown Portland Cement Company in 1908, and, later, Vice-President, retaining this office for two years during the building of the plant.

In 1910 failing health caused Mr. Matcham to retire from active business. He had taken a heavy cold, which settled on his lungs, and in the hope of recovery he spent the spring and summer of 1911 at his summer home at Pocono Pines, in the mountains of Pennsylvania. His condition, however, became so serious that he was removed to his home in Allentown, Pa., where he died.

In 1893, when Mr. Matcham first became interested in the cement industry, the yearly output in the United States was less than 1 000 000 bbl.; at the time of his death this had increased to about 70 000 000 bbl.

The secret of Mr. Matcham's success was his executive ability, his judgment and control of men, and his faculty of getting from them the best of which they were capable. The most prominent of the younger cement engineers of the present time were his co-laborers, and the reduction of the problems of this important manufacture to an actual and exact practice, has resulted from his good judgment in the selection of his associates.

He also displayed great ability in solving the mechanical and chemical problems of cement manufacture, which involved not only the features of grinding and burning the material, but the equally vital ones of labor-saving and mechanical handling. The mills erected under his supervision were fully up to the most advanced practice at the time each was completed.

Some of the more prominent features of cement manufacture due to Mr. Matcham's inventive genius are: A cooler for clinker, a dryer for coal, a dryer for raw material, and a system of feeding pulverized fuel to the kilns, all of which have proved of great value and assistance to the manufacturer. The rotary dryer is largely used in the more important mills in the United States, in the dry process of cement manufacture, and has greatly increased the production. The coal dryer has become a standard method of drying coal previous to its pulverization for fuel use; and while the system of feeding pulverized fuel to cement kilns, devised by Mr. Matcham, was not generally successful, its use brought about a closer study of kiln conditions and may fairly be considered one of the important steps forward in the industry.

Mr. Matcham was married to Miss Margaret Ormrod, a daughter of Mr. and Mrs. George Ormrod, who, with three children, survives him. He was a Republican in politics, and a member of Grace Episcopal Church, of Allentown, Pa.

He was also a member of the American Institute of Mining Engineers, the American Society for Testing Materials, the National Geographical Society, the Manufacturers' Club of Philadelphia, the the Livingston Club, of Allentown, and the Pomfret Club, of Easton, Pa.

Mr. Matcham was elected a Member of the American Society of Civil Engineers on June 5th, 1901.

BASIL HENRY LEATHER, Assoc. Am. Soc. C. E.*

DIED OCTOBER 31ST, 1911.

Basil Henry Leather was born in Rainhill, Lancashire, England, on April 12th, 1865. He was educated at the Huyton College School, near Liverpool, England, and subsequently studied chemistry for several years. From 1884 to 1890 he was engaged in various commercial offices in Liverpool and Birmingham, and in the latter year came to America.

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* Memoir prepared by the Secretary from information furnished by H. H. Knowles, Esq., and from papers on file at the House of the Society.

From 1890 until the spring of 1902 he was with the Neuchatel Asphalt Company, serving as Superintendent of Construction for the last nine years of that period. In the spring of 1902 he formed the Union Construction and Waterproofing Company, of which he was President until his death.

He had charge of the paving of the New York and Brooklyn Terminals of the Brooklyn Bridge, and also the stations of the elevated railway connected therewith, and the flat floor system of the loop tracks around the Plaza in Brooklyn. He also had charge of the paving of the tracks and upper deck platforms of the Jersey City Terminal of the Pennsylvania Railroad, in Jersey City; the water-proofing and heavy concrete foundations of the Manhattan Railroad sub-stations, in New York City; the water-proofing of the manholes of the conduit system of the Manhattan Railroad, and also those of the Telephone Company, where subject to tidal pressure. The asphalt pavements of the flat floor system of the elevated structures on the Nostrand Avenue and Ralph Avenue sections of the Atlantic Avenue Improvement, in Brooklyn, N. Y., were constructed by him, and also two sub-surface power-stations of the Metropolitan Railroad at Forty-second Street and the North River, New York City.

The most severe and particular work accomplished by Mr. Leather was the water-proofing of the lowest sections of the East River Tunnels of the Pennsylvania Railroad Terminal Improvement, New York City, and this probably brought about the complications which caused his death. In this same improvement he also water-proofed the low sections of the Terminal excavations from Seventh to Tenth Avenues and from Thirty-first to Thirty-third Streets.

He was also engaged on much bridge and special work for the Central Railroad of New Jersey, the Delaware, Lackawanna and Western, and the New York, Ontario and Western Railroads. Mr. Leather also constructed battery-room floors for the Manhattan and Metropolitan Railroads and the New York Edison Company, for which latter company he did much other special work during the last ten years.

He was married in 1889 to Margaret Cecilia Quigley, eldest daughter of the late Thomas Quigley, Esq., of Clonmore, County Waterford, Ireland, who, with four sons, survives him.

Mr. Leather was elected an Associate of the American Society of Civil Engineers on June 1st, 1904.

JOSEPH JAMES FERRIER, Jun. Am. Soc. C. E.*

DIED OCTOBER 29TH, 1911.

Joseph James Ferrier was born at Brighton, Sussex, England, on November 26th, 1882. His preliminary education was obtained in the local schools, and he spent considerable time voluntarily on the London, Brighton, and South Coast Railway, under the supervision of his father, who was an Inspector on that road. In 1902 he entered the Lintott Engineering Works, at Horshaw, where he was engaged in foundry work and on agricultural machinery, etc.

In February, 1903, Mr. Ferrier came to the United States and entered the employ of the Mergenthaler Linotype Company, as a Timekeeper, Draftsman, etc. During this time he took a full course in civil engineering with a correspondence school. In 1905 he was engaged as a draftsman on power-house design and details on the Port Morris and Yonkers stations of the New York Central and Hudson River Railroad. He remained with this company until 1907 and had then been promoted to the position of Chief Draftsman, and acted as Assistant to the Engineer of the power-station. In 1907 he resigned this position to accept one with the Southern Pacific Company on the electrification of its lines in and near San Francisco, Cal. Here he was engaged in the design and details of two large power plants, and took a prominent position in the Steam and Mechanical Engineering Branches of the Oakland, Alameda, and Berkeley electrification. Subsequently, he was promoted to the position of Office Engineer, and in this capacity handled many details in connection with this work.

Mr. Ferrier's death occurred on the afternoon of Sunday, October 29th, 1911, at his home in Fruitvale, Cal., the immediate cause being over-exertion in physical culture exercises, which he had been in the habit of taking daily. The shock to his family and friends was intensified by the unexpectedness and the seeming irony of the tragedy, for none was more vital, hopeful, or full of promise than he.

He was an exceedingly able, conscientious, and thorough engineer, and therefore was a very valuable assistant.

Mr. Ferrier was a member of the Masonic Order, the Foresters, and the Eastern Star, and a Junior of the American Society of Mechanical Engineers. He was elected a Junior of the American Society of Civil Engineers on December 3d, 1907.

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* Memoir prepared by the Secretary from information furnished by A. H. Babcock, Esq., and from papers on file at the House of the Society.

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AMERICAN SOCIETY

OF

CIVIL ENGINEERS

CONSTITUTION AND LIST OF MEMBERS

FEBRUARY

1911

FOUNDED
1852

HERMAN W. SPOONER

House of the Society, No. 220 West Fifty-seventh Street, New York City

AMERICAN SOCIETY

OF

CIVIL ENGINEERS

Instituted November 5, 1852.

CONSTITUTION AND LIST OF MEMBERS

FEBRUARY 10th, 1911.

House of the Society, 220 West Fifty-seventh Street,
NEW YORK.

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HOUSE OF THE SOCIETY,

220 West 57th Street.

Cable Address:
"Ceas, New York."

Telephone:
5913 Columbus.

CALENDAR.

1911-12.

DATES OF MEETINGS IN BOLD-FACED TYPE.

FEBRUARY, 1911

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JANUARY, 1912

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NOTE.—Regular meetings are called to order at 8.30 P. M.

The House of the Society is open from 9 A. M. to 10 P. M. every day, except Sundays, Fourth of July, Thanksgiving Day and Christmas Day.

At the time of going to press the date of the Annual Convention had not been fixed.

CONSTITUTION

Adopted March 4th, 1891.*

ARTICLE I.—Name, Location and Object.

1.—The name of this Association shall be the American Society of Civil Engineers.

2.—The offices of the Society shall be located in the City of New York.

3.—Its objects shall be the advancement of engineering knowledge and practice and the maintenance of a high professional standard among its members.

4.—Among the means to be employed for this purpose shall be: meetings for the presentation and discussion of appropriate papers and for social and professional intercourse; the publication of such papers and discussions as may be deemed expedient; the maintenance of a library, the collection of maps, drawings and models, and the establishment of facilities for their use.

ARTICLE II.—Membership.

1.—The Corporate Members of this Society shall be designated as Members and Associate Members. There may also be connected with the Society, Honorary Members, Associates, Juniors, and Fellows who shall be entitled to all the privileges of the Society, except the right to vote and to hold office therein; provided that Honorary Members elected from the Corporate Members of the Society shall retain their right to vote and to hold office.

2.—A Member shall be a Civil, Military, Naval, Mining, Mechanical, Electrical, or other professional Engineer, an Architect or a Marine Architect. He shall be at the time of admission to membership not less than thirty years of age, and shall have been in the active practice of his profession for ten years; he shall have had responsible charge of work for at least five years, and shall be qualified to design as well as to direct engineering works. Graduation from a school of engineering of recognized reputation shall be considered as equivalent to two years' active practice. The performance of the duties of a Professor of Engineering in a technical school of a high grade shall be taken as an equivalent to an equal number of years of actual practice.

3.—An Associate Member shall be a professional Engineer or Architect not less than twenty-five years of age, who shall have been in the active practice of his profession for at least six years, and who shall have had responsible charge of work as principal or assistant for at least one year. Graduation from a school of engineering of recognized reputation shall be considered as equivalent to two years' active practice.

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* Amended October 3d, 1894; March 6th, 1895; October 6th, 1897; October 5th, 1898; October 3d, 1900; March 4th, 1903; October 7th, 1903, and October 7th, 1908.

4.—Any person having the necessary qualifications prescribed in this article to entitle him to admission to the grades of Member or Associate Member, shall be eligible for such membership, though he may not be practicing his profession at the time of making his application.

5.—An Associate shall be a person who, by scientific acquirements or practical experience, has attained a position in his special pursuit qualifying him to co-operate with engineers in the advancement of professional knowledge and practice, but who is not a professional engineer.

6.—A Junior shall not be less than eighteen years of age, and his connection with the Society shall cease when he becomes thirty-two years of age, unless he be previously transferred to another grade. He shall have had active practice in some branch of engineering for at least two years, or he shall have graduated from a school of engineering of recognized standing. Persons who are in the Junior class at the time of the adoption of this Constitution shall not have their status changed by the provisions of this section.

7.—Honorary Members shall be chosen only from persons of acknowledged eminence in some branch of engineering or the sciences related thereto. There shall not be more than twenty at any one time.

8.—Fellows shall be contributors to the permanent funds of the Society, though they may not be eligible for admission as Corporate Members.

ARTICLE III.—Admissions and Expulsions.

1.—Honorary Members shall be proposed by at least ten members, and shall be elected only by a unanimous vote of the Board of Direction. A Past-President, or a member of the Board of Direction proposed for Honorary Membership, shall not be required to vote either for or against his own admission.

A person elected an Honorary Member shall be promptly notified thereof by letter. The election shall be cancelled if an acceptance is not received within six months after the mailing of such notice.

All members other than Honorary Members shall be admitted to the Society only by vote of the Board of Direction, as hereinafter specified.

2.—An application for admission to the Society or for transfer from one grade to another shall embody a concise statement, with dates, of the candidate's professional training and experience; and shall be in a form and in such detail as may be prescribed by the Board of Direction. It shall be signed by the applicant, and shall contain a promise to conform to the requirements of membership, if elected. The applicant shall furnish the names of at least five Corporate Members to whom he is personally known. Each of these shall be requested by the Secretary to address a letter to the Board of Direction, on a form prescribed by said Board, stating the extent of the writer's personal knowledge of the applicant and of his professional work. If at least five of the Corporate Members named as references do not furnish the requisite endorsement, the Secretary shall call upon the applicant for additional names, and not until written communications shall have been received from at least five Corporate Members shall the application be considered by the Board.

Applications of engineers not resident in North America, and who may be so situated as not to be personally known to five Corporate Members, may be recommended for ballot by five members of the Board of Direction, after having secured evidence sufficient, in their opinion, to show that the applicant is worthy of admission.

3.—At stated periods, to be determined by the Board of Direction, there shall be issued to each member in any grade whose address is known, a list of all new applications received for admission or for transfer, which list shall be dated and shall contain a concise statement of the record of each applicant and the names of his references, with a request that members transmit to the Board any information in their possession which may affect the disposition of the applications. Not less than twenty days after the issue of such list, the Board of Direction shall consider these applications, together with any information in regard to the applicants that may have been received; may make further inquiries, if deemed expedient; shall classify the applicant with his consent, and on applications for admission shall vote thereon by ballot.

The Board shall have the power to elect persons to any grade, and to transfer persons from any grade to a higher grade of membership, and shall notify the membership of its action.

4.—The ballots shall be letter-ballots, in a form to be prescribed by the Board of Direction. They shall be mailed to each member of the Board of Direction, and shall state the date on which the ballot is to be canvassed, which shall be not less than twenty days after the issue of the ballot. At least twenty-five votes must be cast to constitute an election. Three or more negative votes shall exclude from election. In case of exclusion, no notice thereof shall be entered on the minutes, but the candidate shall be notified.

A rejected applicant may renew his application for membership or transfer at any time after the expiration of one year from the date of the ballot rejecting his previous application.

5.—All elected candidates shall be duly notified and shall subscribe to the Constitution and Rules of the Society. Forms for these purposes shall be prescribed by the Board of Direction. If these provisions are not complied with within six months from the notification of election, such election shall be considered void unless for special reason the time shall be extended by the Board of Direction.

Membership of any person shall date from the day of his election.

6.—Upon the written request of ten or more Corporate Members, that for cause therein set forth a person belonging to the Society be expelled, the Board of Direction shall consider the matter, and if there appears to be sufficient reason, shall advise the accused of the charges against him. He may, if he so desires, present a written defence which shall be considered at a meeting of the Board of Direction, of which he shall receive due notice. Not less than two months after such meeting, the Board of Direction shall finally consider the case, and if resignation has not been tendered, or a defence made which is satisfactory to the Board, it shall then notify the person that he will be expelled in one month, unless he elects to appeal from this decision. Appeals will be submitted to the Corporate Members by letter-ballot in a form to be prescribed by the Board of Direction. The ballot shall be accompanied by a statement of the charges, and of the action of the Board thereon, with such information as it deems proper, and also the statement of the person making the appeal. The ballot shall be canvassed by the Board not less than twenty days after its issue. A majority of the ballots cast will be required to sustain the action of the Board. The Board will notify the person and the Corporate Members of the result of the ballot. In case no appeal be made, the Board of Direction will expel the person, and notify him and the Corporate Members of its action.

7.—A member of any grade in the Society may resign his membership by a written communication to the Secretary, who shall present the same to the Board of Direction; when, if all his dues have been paid, his resignation shall be accepted.

8.—All persons elected and duly qualified, whose address on the records of the Society is within fifty miles of the Post Office in the City of New York, shall be deemed Resident; and those whose address is beyond that limit shall be deemed Non-Resident.

The classification of each person for the fiscal year as Resident or Non-Resident, shall be determined by the Records of the Society as they may appear on January 1st of that year.

ARTICE IV.—Dues.

1.—The entrance fees payable on admission to the Society shall be as follows: by Members, thirty dollars; Associate Members, twenty-five dollars; Associates, twenty dollars; Juniors, ten dollars.

2.—The annual dues payable by members, whether Resident or Non-Resident, shall be as follows: by Corporate Members, fifteen dollars; Associates, ten dollars; Juniors, ten dollars.

3.—In addition to the dues prescribed in the preceding section, each Resident Member shall pay annually as follows: Corporate Members, ten dollars; Associates, five dollars; Juniors, five dollars.

4.—A person transferred from any grade to a higher one shall pay the difference between the entrance fees of the two grades, and his annual dues shall be those of the higher grade.

5.—The annual contributions shall become due for the ensuing year on the first day of January, and shall be payable in advance. It shall be the duty of the Secretary to notify each member of the amount due for the ensuing year at the time of giving notice of the Annual Meeting.

6.—Persons elected after six months of any fiscal year shall have expired, shall pay only one-half of the amount of dues for that fiscal year.

7.—All future annual dues may be compounded by a single payment by a Corporate Member of $250; or by an Associate of $150. Should a compounding Associate be elected to Corporate Membership he shall pay the further sum of $100.

Provided, that all compounding Corporate Members or Associates who may be or hereafter become Resident, shall be and remain liable for the annual payment of the difference between the annual dues of Resident and Non-Resident Corporate Members, or Associates; but any Corporate Member may at any time compound for the future payment of all annual dues of every nature and kind by the payment of $75 in addition to the $250 hereinbefore named; and any Associate may at any time compound for the future payment of all annual dues as Associate by the payment of $40 in addition to the $150 hereinbefore named.

Provided, that any person desiring to compound for future dues shall have paid his entrance fee, all arrears of dues, and the annual dues for the current year, before the compounding sum may be available.

Persons compounding shall sign an agreement that they will be governed by the Constitution and Laws of the Society as they are now formed, or as they may be hereafter altered, amended or enlarged; and that in case of their ceasing to be connected with the Society from any cause whatever, the amount theretofore paid by them for compounding, and for entrance fees and annual dues, shall be the property of the Society.

All moneys thus paid in commutation of annual dues shall be invested as a permanent fund, only the interest thereupon being subject to appropriation for current expenses.

8.—Any person whose dues are more than three months in arrears shall be notified by the Secretary. Should his dues not be paid when they become six months in arrears, he shall lose the right to vote or to receive the publications of the Society. Should his dues become nine months in arrears, he shall again be notified in form prescribed by the Board of Direction, and if such dues become one year in arrears, he shall forfeit his connection with the Society. The Board of Direction, however, may, for cause deemed by it sufficient, extend the time for payment and for the application of these penalties.

9.—The Board of Direction may, for sufficient cause, temporarily excuse from payment of annual dues any member who from ill health, advanced age, or other good reason assigned, is unable to pay such dues; and the Board may remit the whole or part of dues in arrears, or accept in lieu thereof, desirable additions to the Library, or collections.

10.—Every person admitted to the Society shall be considered as belonging thereto and liable for the payment of all dues until he shall have resigned, been expelled, or have been relieved therefrom by the Board of Direction.

11.—Persons elected as Fellows shall become such upon the payment of Two Hundred and Fifty dollars into the permanent funds of the Society. They shall not be liable for other fees and dues.

12.—The status of any present subscribers shall not be changed by the provisions of this Constitution.

ARTICLE V.—Officers.

1.—The officers of the Society shall be a President, four Vice-Presidents, eighteen Directors, a Secretary, and a Treasurer, who, with the five latest living Past-Presidents, who continue to be members, shall constitute the Board of Direction in which the government of the Society shall be vested, and who shall be the Trustees as provided for by the laws under which the Society is organized. For the election of Honorary Members, all the Past-Presidents shall be members of the Board of Direction, except any Past-President who may be disqualified by mental or bodily infirmity, and the evidence of said disqualification shall be a written certificate from his attending physician, or some officer of the Society.

2.—The terms of office of the President, Secretary and Treasurer shall be one year; of the Vice-Presidents, two years; and of the Directors, three years. Provided, however, that at the first election after the adoption of this Constitution, four Vice-Presidents and eighteen Directors shall be elected, of whom two Vice-Presidents and six Directors shall be elected to serve for one year only, and six Directors for two years only; provided, also, that after the first election two Vice-Presidents and six Directors shall be elected each year.

The term of each officer shall begin at the close of the Annual Meeting at which such officer is elected, and shall continue for the period above named or until a successor is duly elected.

3.—A vacancy in the office of President shall be filled by the senior Vice-President.

A vacancy in the office of Vice-President shall be filled by the senior Director. Seniority between persons holding similar offices shall be determined by priority of election to the office, and when these dates are the same, by priority of admission to Corporate Membership; and when the latter dates are identical, the selection shall be made by lot. In case of the disability or neglect in the performance of his duty, of any officer of this Society, the Board of Direction shall have power to declare the office vacant. Vacancies in any office for the unexpired term shall be filled by the Board of Direction, except as provided above.

4.—The President shall be ineligible for re-election. The Vice-Presidents and Directors shall not be eligible for re-election to the same office until at least one full term shall have elapsed after the end of their respective terms.

5.—At least one Vice-President, the Secretary and the Treasurer, and six Directors shall be Resident Corporate Members during their term of office.

ARTICLE VI.—Management.

1.—The President shall have a general supervision of the affairs of the Society. He shall preside at meetings of the Society and of the Board of Direction at which he may be present, and shall be *ex-officio* member of all committees. He shall deliver an address at the Annual Convention.

The Vice-Presidents in order of seniority shall preside at meetings in the absence of the President, and discharge his duties in case of a vacancy in the office.

2.—The Board of Direction shall manage the affairs of the Society in conformity to the laws under which the Society is organized and the provisions of this Constitution. It shall direct the investment and care of the funds of the Society; make appropriations for specific purposes; act upon applications for membership as heretofore provided; take measures to advance the interests of the Society; appoint all its employees; and generally direct its business. The Board of Direction shall make an annual report at the Annual Meeting, transmitting the report of the Treasurer and of other officers, and of Committees.

3.—The Treasurer shall receive all moneys and deposit the same in the name of the Society. He shall invest all funds not needed for current disbursements, as shall be ordered by the Board of Direction. He shall pay all bills, when certified and audited, as provided by this Constitution and by rules to be prescribed by the Board of Direction. He shall make an annual report and such other reports as may be prescribed by the Board of Direction.

The Board of Direction shall secure a satisfactory surety for the faithful performance of his duties by the Treasurer, and shall renew the same during the month of January of each year.

4.—The Secretary shall be a Corporate Member of the Society. He shall be elected annually by the Board of Direction at the meeting to be held within twenty days after the Annual Meeting provided for in Section 7 of Article VI, or at an adjournment thereof, and shall hold the office for one year or until his successor is elected, provided that a majority of the whole Board of Direction shall be required to elect the Secretary; this vote to be given, if necessary, by letter.

He shall be, under the direction of the President and Board of Direction, the executive officer of the Society.

He will be expected to attend all meetings of the Society and of the Board of Direction; prepare the business therefor, and duly record the proceedings thereof.

He shall see that all moneys due the Society are carefully collected, and without loss transferred to the custody of the Treasurer.

He shall carefully scrutinize all expenditures, and use his best endeavor to secure economy in the administration of the Society.

He shall personally certify the accuracy of all bills or vouchers on which money is to be paid, and shall countersign the checks drawn by the Treasurer against the funds of the Society, when such drafts are known to him to be proper and duly authorized by the Finance Committee.

He shall have charge of the books of account of the Society, and shall furnish monthly to the Board of Direction a statement of receipts and expenses under their several headings, and also a statement of monthly balances. He shall present annually, to the Board of Direction, a balance sheet of his books, as of the 31st of December, and shall furnish, from time to time, such other statements as may be required of him.

He shall conduct the correspondence of the Society and keep full records of the same.

He shall have charge of the Society's house and its contents; shall supervise the work of all employees of the Society, and see that they diligently perform their respective duties.

He shall perform all other duties which may from time to time be assigned to him by the Board of Direction.

5.—The Board of Direction may also, if they deem it necessary, appoint an Assistant Secretary, who shall aid the Secretary and be under his immediate direction in all matters. His whole time shall be given to the Society.

6.—The Secretary and Treasurer shall be paid salaries to be determined by the Board of Direction; but such salaries shall not be reduced during the term of office, as provided in this Constitution. All other salaries shall be fixed, from time to time, by the Board of Direction.

7.—The Board of Direction shall meet within twenty days after the Annual Meeting, and shall then appoint from its members a Finance Committee of five, a Library Committee of five, and a Committee on Publications of five. At least three members of the Finance Committee, and two members of the other Committees, shall be resident within fifty miles of New York.

These Committees shall report to the Board of Direction, and perform their duties under its supervision.

8.—The Finance Committee shall have immediate supervision of the financial affairs of the Society; shall employ an expert accountant to audit the accounts monthly; shall approve all bills before payment, and shall make recommendations to the Board of Direction as to the investment of moneys, and as to other financial matters.

9.—The Library Committee shall have general supervision of the Library and the House of the Society and the property therein; shall make recommendations to the Board with reference thereto, and shall direct the expenditure for books and other articles of permanent value, of such sums as may be appropriated for these purposes.

10.—The Committee on Publications shall have general supervision of the publications of the Society, and of contracts and expenditures connected therewith.

11.—In the consideration of papers offered for presentation, those papers containing matter readily found elsewhere, those specially advocating personal interests, those carelessly prepared or controverting established facts, and those purely speculative or foreign to the purposes of the Society, shall be rejected. The Committee on Publications shall determine which papers shall be read in full, and which shall be printed after reading by title only. The Committee may return a paper to the writer for correction and emendation, and call to its aid one or more members of special experience relating to the subject treated, either to advise on the paper or to discuss it. Such papers as in the judgment of the Committee should appear in the *Transactions*, shall promptly, upon their acceptance, be printed and distributed to members of all grades; others shall, with the consent of the authors, be suitably indexed, and filed for reference, or the Committee may provide abstracts thereof, which, when approved by the authors, may be published instead of the original papers. Advance copies of papers and discussions may be sent out to the membership before final publication.

12.—Special committees to report upon engineering subjects shall be authorized, except as further provided in this paragraph, by a majority of the votes cast by the Society, and in the following manner: A proposition to appoint such a Committee shall be presented at a regular meeting of the Society, and if sustained, on a motion to refer the same to the Board of Direction, by an affirmative vote of not less than twenty-five Corporate Members, it shall be so referred.

The Board of Direction shall then consider the same and report its recommendations to the Society at the next general business meeting, together with a statement of the arguments for and against the appointment of such Committee.

If a motion for the issue of a letter-ballot thereon receive the affirmative vote of two-thirds of the Corporate Members present, the Board of Direction shall, within thirty days thereafter, issue the letter-ballot, accompanied by a statement of the arguments for and against the proposition.

A majority of a total vote of not less than one-third of the Corporate Membership of the Society shall be necessary for its adoption, whereupon the Committee so authorized shall be appointed by the Board of Direction.

Whenever, in the judgment of the Board of Direction, a special committee, appointed in the above prescribed manner, by reason of the long time required for its appointment, would be defeated in its object and be of no avail, then the Board of Direction shall be authorized to appoint forthwith a special committee to act in each case and report on each subject; the Board of Direction to report its action to the Society at its next regular meeting.

ARTICLE VII.—Nomination and Election of Officers.

1.—The Board of Direction shall, from time to time, divide the territory occupied by the membership into seven geographical districts, to be designated by numbers. District No. 1 shall be the territory within fifty miles of the Post Office in the City of New York. Each of the other six districts shall be, as nearly as practicable, contiguous territory; each shall contain, as nearly as practicable, an equal number of members, and they shall be designated as Districts Nos. 2, 3, 4, 5, 6 and 7. The Board shall announce such division to the Society on or before the first day of May in each year.

2.—At the Annual Meeting of each year, seven Corporate Members, not officers of the Society, one from each of the geographical districts, shall be appointed by the meeting to serve for two years; who, with the five living last Past-Presidents of the Society, shall be a committee to nominate officers for the Society.

The Board of Direction may prescribe the mode of procedure for appointing this Committee, and fill any vacancies occurring.

The Committee so appointed shall meet at the Annual Convention of the Society, and nominate candidates to fill the offices, named in Article V, so as to provide, with the officers holding over, a Vice-President and six Directors residing in District No. 1, and twelve Directors divided equally, with regard to number and residence, among the remaining districts, Nos. 2, 3, 4, 5, 6 and 7.

A list of nominees for the offices to be filled at the next Annual Election shall be presented by the Committee to the Board of Direction within ten days after the nominees have been selected.

3.—Directly after the first of October the aforesaid list of nominees shall be mailed to every Corporate Member whose address is known, provided that if any person shall be found by the Board of Direction to be ineligible for the office for which he is nominated, or should a nominee decline such nomination, his name shall not be sent out, but the Board shall substitute another name therefor. The Board shall also fill any vacancies that may occur in this list of nominees up to the time the ballots are sent out. Vacancies must be so filled as to preserve the geographical distribution of officers prescribed in Section 2 of this article.

4.—At any time before the first day of December, any ten or more Corporate Members may send to the Secretary additional nominations, signed by such members; but nominations so made must comply with Section 2 of this article, regarding the distribution of nominees among the several districts.

5.—At least thirty days before the Annual Meeting, there shall be mailed to every Corporate Member whose address is known a letter-ballot with envelopes for voting. This ballot shall include all the nominations made in accordance with this article. The names and residences of the nominees, their grades of membership, and, in the case of nominees for Directors, the number of the district in which they reside, shall be given. The names of the nominees for any one office shall be arranged alphabetically without distinguishing marks of any kind other than the designations named herein.

Voters may erase names from the printed ballot-list and may substitute the name or names of any other person or persons eligible for any office. But the number of names for each office on the ballot voted must not exceed the number to be elected at that time to such office, and the vote must be for the proper number of officers resident in each of the seven districts. Ballots not complying with these provisions shall be rejected.

Directions in accordance with these provisions shall be issued with the ballots.

6.—Ballots may be sent by mail to the Secretary, or may be presented to him at the Society House. They must be enclosed in two sealed envelopes, and the outer envelope shall be endorsed by the voter's signature.

The Secretary shall make from the signatures on the outer envelopes a list of the voters from whom ballots are received, which list shall be open to inspection by all Corporate Members. A voter may withdraw his ballot, and may substitute another, at any time before the polls close.

7.—The polls shall be closed at 12 o'clock noon on the first day of the Annual Meeting, and the ballots shall be canvassed publicly by tellers, who shall be appointed by the presiding officer.

The persons of each district who shall receive the highest number of votes for the office for which they are candidates shall be declared elected.

In case of a tie between two or more candidates for the same office, the Annual Meeting shall elect the officer from among the candidates so tied.

The presiding officer shall announce to the meeting the names of the officers elected, in accordance with this section.

ARTICLE VIII.—Meetings.

1.—A Convention ot the Society for the reading and discussion of professional papers and for social intercourse shall be held annually at such time and place as the Society may determine.

2.—There shall be two general Business Meetings of the Society each year; the Annual Meeting, which shall be held at the offices of the Society on the third Wednesday in January, and at which the annual reports for the year ending December 31st previous shall be presented, and the ballot for officers canvassed; and a Business Meeting during the Annual Convention, which shall be held at a time and place to be determined by the Board of Direction.

At these meetings thirty Corporate Members shall constitute a quorum.

3.—Business Meetings shall be held monthly on the first Wednesday of each month, except during the months of July and August. At these meetings thirty Corporate Members shall constitute a quorum.

4.—In addition to the Annual Meeting and the Annual Convention meetings for the reading and discussion of papers shall be held as ordered by the Board of Direction.

5.—Special meetings may be called by the Board of Direction, and shall be so called on the request of thirty Corporate Members, which request shall state the purpose of such meeting. The call for such meetings shall be issued ten days in advance, and shall state the purpose thereof, and no other business shall be taken up at such meeting. At these meetings thirty Corporate Members shall constitute a quorum.

6.—The Society may adopt, from time to time, rules for the order of business at its meetings.

7.—Meetings of the Board of Direction shall be held at the time of the Annual Meeting and of the Annual Convention, at which meeting nine members shall constitute a quorum; and at such other times as the Board may determine, at which five members shall constitute a quorum.

ARTICLE IX.—AMENDMENTS.

1.—Proposed amendments to this Constitution must be reduced to writing and signed by not less than five Corporate Members, and be submitted and acted upon as follows:

2.—Amendments presented to the Secretary on or before the first Wednesday in November shall be sent by letter to the several Corporate Members of the Society at least twenty-five days previous to the Annual Meeting. Such amendments shall be in order for discussion at such Annual Meeting, and may be amended in any manner pertinent to the original amendments by a majority vote of the Annual Meeting, and if so amended shall be voted upon by letter-ballot in form as amended by the Annual Meeting; if not so amended, they shall be voted upon by letter-ballot as submitted. The vote to be counted at the first regular meeting in March.

3.—Amendments presented to the Secretary not less than sixty days previous to the date of the Annual Convention shall be sent by letter to the several Corporate Members of the Society at least twenty-five days previous to the Annual Convention. Said amendments shall be in order for discussion at the Business Meeting during such Annual Convention, and may be amended in any manner pertinent to the original amendments by a majority vote of the Business Meeting during the Annual Convention, and, if so amended, shall be voted upon by letter-ballot in form as amended by said Business Meeting; if not so amended, they shall be voted upon by letter-ballot as submitted. The vote to be counted at the first regular meeting in October.

4.—If, after discussion of a proposed amendment, at either of the general meetings of the Society, the meeting shall so decide by a majority vote, it may refer the amendment to a Committee for further consideration, which Committee shall report at the next general meeting, whereupon the amendment shall be voted upon as hereinbefore provided.

5.—An affirmative vote of two-thirds of all ballots cast shall be necessary to the adoption of any amendment.

Amendments so adopted shall take effect thirty days after their adoption, provided that the officers of the Society, at the time any amendment may be adopted, shall continue in office until the next Annual Election.

GENERAL INFORMATION

Meetings.—Regular meetings are held at the House of the Society, No. 220 West Fifty-seventh Street, New York, on the first and third Wednesdays of each month, at 8.30 p. m., except during the summer. The Annual Meeting is held on the third Wednesday in January. A Convention is held annually, at a time and place determined each year by the Society.

The House and Library of the Society are open from 9 a. m. to 10 p. m. every day, except Sundays, Fourth of July, Thanksgiving Day and Christmas Day.

Publications.—The Society issues two publications, *Proceedings* and *Transactions*, which are furnished without extra charge to members of every grade. Subscription to *Proceedings* per annum is $8. Single copies are $1 each. A special subscription rate of $4.50 per annum has been fixed for the *Proceedings*, for the benefit of students in technical schools. The subscription to *Transactions* per annum is $12. Single volumes are $4 each. Discount to members, libraries, book dealers, etc., 25 per cent. There is also an additional charge per annum, to cover foreign postage, of 75 cents for *Proceedings* and $1 for *Transactions*, or 8 cents and 25 cents, respectively, for single numbers.

Ten numbers of *Proceedings* are issued during the year, the numbers appearing on the fourth Wednesday of each month except June and July. Each number contains minutes of meetings, announcements of matters of current interest, a classified list of current engineering articles, and a list of new books received in the Library. Papers to be subsequently presented, as well as some of the discussions to which they give rise, are also published in *Proceedings*.

The papers with complete discussions are subsequently republished in the volumes of *Transactions*, which, beginning with March 31st, 1909, have been issued quarterly. Each volume contains from 500 to 600 pages, and is bound in paper covers; arrangements have also been made for furnishing these volumes bound in standard cloth (50 cents), or half morocco ($1), to members who desire to pay for them in that form.

Professional Papers.—Papers and discussions on subjects of engineering interest are invited by the Board of Direction from all persons, whether members of the Society or not, subject to proper editorial supervision. Under the Constitution, matter which may be readily found elsewhere, advocates personal interests, is carelessly prepared, controverts established facts, or is purely speculative or foreign to the purposes of the Society, must be excluded.

GENERAL INFORMATION

Under a recent decision of the Board of Direction, papers will be divided into two classes, those which are of such general interest and of such form as to be adapted for oral discussion, and those which by reason of their technical nature cannot readily be discussed orally. Papers which form the first of these classes will be set down for presentation to a meeting of the Society, and oral as well as written discussion is solicited. Those coming under the second class will be published in *Proceedings*, and will not be presented at any meeting, but written discussions will be asked for, which will be published subsequently with the paper in the Volumes of *Transactions*.

All papers, on their acceptance by the Committee on Publications, become the property of the Society.

Additions to Library.—It is desirable that copies of books on engineering subjects, and of reports of municipal, railway, canal, water supply and all other public works, be added to the Library. Members of the Society, and all who feel an interest in the proper maintenance of a technical reference library, are asked to donate engineering books or reports.

Admission to Membership.—The requirements for each of the grades of membership may be found on pages 5 and 6.

For blank forms and other information, address the Secretary, at the Society House.

Fees and Dues.	Resident.				Non-Resident.			
	Members.	Associate Members.	Associates.	Juniors.	Members.	Associate Members.	Associates.	Juniors.
Entrance Fee	$30.00	$25.00	$20.00	$10.00	$30.00	$25.00	$20.00	$10.00
Yearly Assessment	25.00	25.00	15.00	15.00	15.00	15.00	10.00	10.00
Total, payable upon Election	$55.00	$50.00	$35.00	$25.00	$45.00	$40.00	$30.00	$20.00

Fellowship fee, $250 in one payment for life.

Annual dues are payable in advance on the 1st day of January.

Members elected during the last half of the year pay only one-half of the amount of dues for that year.

Compounding Dues.—The annual dues of a Corporate Member may be compounded by a single payment of $250; of an Associate by a payment of $150. Should a compounding Associate be elected to Corporate Membership, an additional payment of $100 is necessary.

All compounding Corporate Members or Associates, who may be or hereafter become Resident, remain liable for the annual payment of the difference between the annual dues of Resident and Non-Resident Corporate Members or Associates; but any Corporate Member may at any time compound for the future payment of all annual dues of every nature and kind by the payment of $75 in addition to the $250 hereinbefore named; and any Associate may at any time compound for the future payment of all annual dues as Associate by the payment of $40 in addition to the $150 hereinbefore named.

Any person compounding his dues must have paid his entrance fee, all arrears of dues, and the annual dues for the current year, before the compounding sum can be accepted.

Persons compounding shall sign an agreement that they will be governed by the Constitution and Laws of the Society as they are now formed, or as they may be hereafter altered, amended or enlarged; and that in case of their ceasing to be connected with the Society from any cause whatever, the amount theretofore paid by them for compounding, and for entrance fees and annual dues, shall be the property of the Society.

CERTIFICATES OF MEMBERSHIP.—The prices, to cover cost of Certificates, are as follows:

Parchment	$2.25
Parchment Paper	1.25

Certificates are not issued to Juniors.

BADGE.—This is of gold and enameled (Blue for Corporate Members, and Maroon for Associates and Fellows), with the member's name and membership number engraved on the back, and is mounted either as an ordinary pin, a scarf pin, a watch charm, or a button. The price is $5. Badges can be secured only upon application to the Secretary. They are not issued to Juniors.

REMITTANCES.—All remittances should be made payable to the order of the American Society of Civil Engineers.

THE SEVEN GEOGRAPHICAL DISTRICTS INTO WHICH THE TERRITORY OCCUPIED BY THE MEMBERSHIP IS DIVIDED, UNDER ART. VII, SEC. 1, OF THE CONSTITUTION

District No. 1.—The territory within 50 miles of the Post-Office in the City of New York.

District No. 2.—The States of Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, and Connecticut (except as included in District No. 1), and all countries in Europe and Africa.

District No. 3.—The States of New York and New Jersey (except as included in District No. 1), the States of Michigan, Wisconsin, and Minnesota, the Territory of Alaska, and the Dominion of Canada.

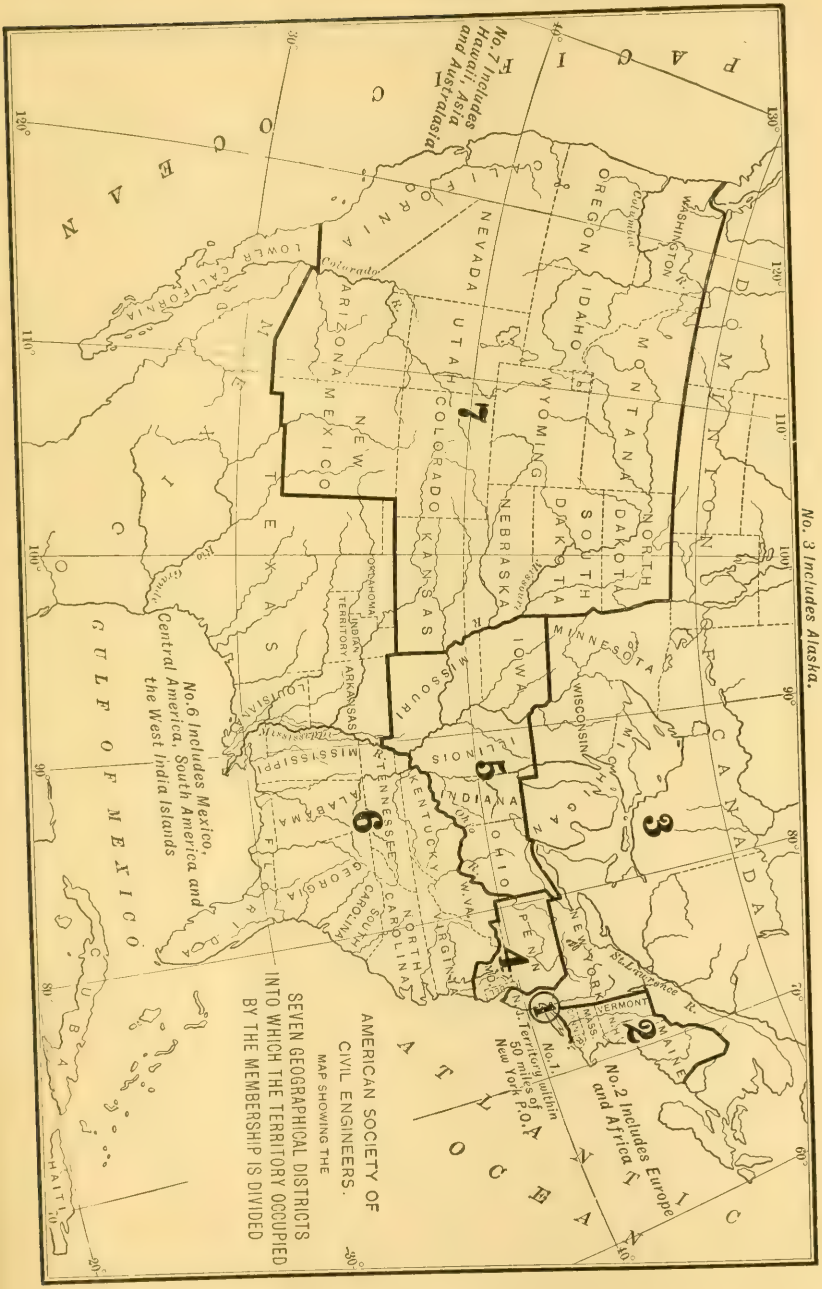
District No. 4.—The States of Pennsylvania, Delaware, and Maryland, and the District of Columbia.

District No. 5.—The States of Ohio, Indiana, Illinois, Iowa, and Missouri.

District No. 6.—The States of Virginia, West Virginia, North Carolina, South Carolina, Georgia, Florida, Kentucky, Tennessee, Alabama, Mississippi, Arkansas, Louisiana, Oklahoma, and Texas; the Republic of Mexico; the West India Islands; and all countries in Central America and South America.

District No. 7.—The States of North Dakota, South Dakota, Nebraska, Kansas, Montana, Wyoming, Colorado, Idaho, Utah, Washington, Oregon, California, and Nevada; the following Territories: New Mexico, Arizona, Hawaii; and all countries in Asia and Australasia.

These Districts are shown on the map on the next page.



AMERICAN SOCIETY OF CIVIL ENGINEERS.

MAP SHOWING THE SEVEN GEOGRAPHICAL DISTRICTS INTO WHICH THE TERRITORY OCCUPIED BY THE MEMBERSHIP IS DIVIDED

No. 1. Territory within 50 miles of New York P.O.

No. 2 Includes Europe and Africa

No. 3 Includes Alaska.

No. 6 Includes Mexico, Central America, South America and the West India Islands

No. 7 Includes Hawaii, Asia and Australasia

RULES GOVERNING THE AWARD OF THE NORMAN MEDAL, THE THOMAS FITCH ROWLAND PRIZE, AND THE COLLINGWOOD PRIZE FOR JUNIORS

Prizes.

There are at present three endowed prizes for papers published in the *Transactions* of the American Society of Civil Engineers. These prizes are awarded annually.

With the assent and the approval of the donors, by action of the Board of Direction, June 1st, 1897, the Society assumes the responsibility for the payment in perpetuity of the Norman Medal, Thomas Fitch Rowland Prize, and Collingwood Prize.

Committee on Prizes.

1. The Board of Direction shall appoint annually, not later than its regular meeting in June of each year, three Corporate Members of the Society, not members of the Board of Direction, who shall form a Committee to recommend the award of all prizes during the year.

2. The papers considered shall include all papers published in the *Transactions* during the year ending with the month of July.

3. The Committee on Prizes shall report its recommendation to the Board of Direction on or before December 31st, and the awards shall be made by the Board of Direction.

4. The announcement of the awards shall be made at the Annual Meeting.

5. The Secretary of the Society shall act as Secretary to the Committee on Prizes, but shall have no vote or voice in its deliberations.

Code of Rules.

The Norman Medal.—The Norman Medal was instituted and endowed in 1872 by the late George H. Norman, M. Am. Soc. C. E.

I. Competition for the Norman Medal of the American Society of Civil Engineers shall be restricted to members of the Society.

II. There shall be one gold medal awarded as hereinafter provided. The dies therefor shall be deposited with the Superintendent of the United States Mint at Philadelphia, in trust exclusively for the above purpose. Such medal shall be of a value of $60.

III. All original papers presented to the Society by members of any class, and published in the *Transactions* during the year for which the medal is awarded, shall be open to the award, provided that such papers shall not have been previously contributed in whole or in part to any other association, nor have appeared in print prior to their publication by the Society, nor have been published in the *Transactions* in any previous year.

IV. The medal shall be awarded to a paper which shall be judged worthy of special commendation for its merit as a contribution to engineering science.

The Thomas Fitch Rowland Prize.—The Thomas Fitch Rowland Prize was originally instituted by the Society at the Annual Meeting of 1882. It was endowed in 1884 by the late Thomas Fitch Rowland, Hon. M. Am. Soc. C. E. Its award is not restricted to members of the Society.

I. The prize shall consist of $60 in cash, with an engraved certificate signed by the President and Secretary of the Society.

II. In the award of this prize preference shall be given to papers describing in detail accomplished works of construction, their cost, and errors in design and execution.

The Collingwood Prize for Juniors.—The Collingwood Prize for Juniors was instituted and endowed in 1894 by Francis Collingwood, M. Am. Soc. C. E.

I. The competition for the prize shall be restricted to the Juniors of the Society.

II. The prize shall consist of $50 in cash, with an engraved certificate signed by the President and Secretary of the Society.

III. The prize shall be awarded to a paper describing an engineering work with which the writer has been directly connected, or it shall record investigations contributing to engineering knowledge, some essential part of which was made by the writer, and contain a rational digest of results. Any mathematical treatment must show immediate adaptability to professional practice. Accuracy of language and excellence of style will be factors in the award.

IV. These rules may be modified by the Board of Direction.

The awards of the Norman Medal, the Thomas Fitch Rowland Prize, and the Collingwood Prize for Juniors are indicated in the List of Members by the letters N., R., and C., respectively, prefixed to the name of each recipient.

AWARDS OF THE NORMAN MEDAL

1874. J. James R. Croes, for paper "Memoir of the Construction of a Masonry Dam." Vol. III,* p. 337.

1875. Theodore G. Ellis, for paper "Description and Results of Hydraulic Experiments with Large Apertures, at Holyoke, Mass., in 1874." Vol. V,* p. 19.

1877. William W. Maclay, for paper "Notes and Experiments on the Use and Testing of Portland Cement." Vol. VI,* p. 311.

Book Prize awarded to Julius H. Striedinger, for paper "On Igniting Blasts by Means of Electricity." Vol. VII,* p. 1.

1879. Edward P. North, for paper "The Construction and Maintenance of Roads." Vol. VIII,* p. 95.

Book Prize awarded to Max E. Schmidt, for paper "Notes on the South Pass Jetties." Vol. VIII,* p. 189.

1880. Theodore Cooper, for paper "The Use of Steel for Bridges." Vol. VIII,* p. 263.

1881. L. L. Buck, for paper "The Re-Enforcement of the Anchorage and Renewal of the Suspended Superstructure of the Niagara Railroad Suspension Bridge." Vol. X,* p. 195.

1882. A. Fteley and F. P. Stearns, for paper "Description of Some Experiments on the Flow of Water Made During the Construction of Works for Conveying the Water of Sudbury River to Boston." Vol. XII,* p. 1.

1883. William P. Shinn, for papers "On the Increased Efficiency of Railways for the Transportation of Freight." Vol. XI,* p. 365; and "How can Railways be made more Efficient in the Transportation of Freight?" Vol. XII,* p. 189.

1884. James Christie, for paper "Experiments on the Strength of Wrought-Iron Struts." Vol. XIII,* p. 85.

1885. Eliot C. Clarke, for paper "Record of Tests of Cement Made for Boston Main Drainage Works." Vol. XIV,* p. 141.

1886. Edward Bates Dorsey, for paper "English and American Railroads Compared." Vol. XV,* p. 1.

1887. Desmond FitzGerald, for paper "Evaporation." Vol. XV,* p. 581.

1888. E. E. Russell Tratman, for paper "English Railroad Track." Vol. XVIII,* p. 217.

1889. Theodore Cooper, for paper "American Railroad Bridges." Vol. XXI,* p. 1.

1890. John R. Freeman, for paper "Experiments Relating to the Hydraulics of Fire Streams." Vol. XXI,* p. 303.

1891. John R. Freeman, for paper "The Nozzle as an Accurate Water Meter." Vol. XXIV,* p. 492.

1892. William Starling, for paper "Some Notes on the Holland Dikes." Vol. XXVI,* p. 559.

1893. Desmond FitzGerald, for paper "Rainfall, Flow of Streams, and Storage." Vol. XXVII,* p. 253.

1894. Alfred E. Hunt, for paper "A Proposed Method of Testing Structural Steel." Vol. XXX,* p. 181.

1895. William Ham. Hall, for paper "The Santa Ana Canal of the Bear Valley Irrigation Company." Vol. XXXIII,* p. 61.

1896. John E. Greiner, for paper "What is the Life of an Iron Railroad Bridge?" Vol. XXXIV,* p. 294.

1897. Julius Baier, for paper "Wind Pressures in the St. Louis Tornado, with Special Reference to the Necessity of Wind Bracing for High Buildings." Vol. XXXVII,* p. 221.

1898. B. F. Thomas, for paper "Movable Dams." Vol. XXXIX,* p. 431.

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* *Transactions*, Am. Soc. C. E.

1899. E. Herbert Stone, for paper "The Determination of the Safe Working Stress for Railway Bridges of Wrought Iron and Steel." Vol. XLI,* p. 467.

1900. James A. Seddon, for paper "River Hydraulics." Vol. XLIII,* p. 179.

1902. Gardner S. Williams, Clarence W. Hubbell and George H. Fenkell, for paper "Experiments at Detroit, Mich., on the Effect of Curvature upon the Flow of Water in Pipes." Vol. XLVII,* p. 1.

1904. Emile Low, for paper "The Breakwater at Buffalo, New York." Vol. LII,* p. 73.

1905. C. C. Schneider, for paper "The Structural Design of Buildings." Vol. LIV,* p. 371.

1906. John S. Sewell, for paper "The Economical Design of Reinforced Concrete Floor Systems for Fire-Resisting Structures." Vol. LVI,* p. 252.

1907. Leonard M. Cox, for paper "The Naval Floating Dock—Its Advantages, Design and Construction." Vol. LVIII,* p. 97.

1908. C. C. Schneider, for paper "Movable Bridges." Vol. LX,* p. 258.

1909. J. A. L. Waddell, for paper "Nickel Steel for Bridges." Vol. LXIII,* p. 101.

1910. C. E. Grunsky, for paper "The Sewer System of San Francisco, and a Solution of the Storm-Water Flow Problem." Vol. LXV,* p. 294.

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* *Transactions*, Am. Soc. C. E.

AWARDS OF THE THOMAS FITCH ROWLAND PRIZE*

1883. G. LINDENTHAL, for paper "Rebuilding the Monongahela Bridge, at Pittsburgh, Pa." Vol. XII,† p. 353.
1884. HAMILTON SMITH, JR., for paper "Water Power with High Pressures and Wrought-Iron Water Pipe." Vol. XIII,† p. 15.
1885. A. M. WELLINGTON, for paper "Experiments with New Apparatus on Journal Friction at Low Velocities." Vol. XIII,† p. 409.
1886. CHARLES C. SCHNEIDER, for paper "The Cantilever Bridge at Niagara Falls." Vol. XIV,† p. 499.
1887. WILLIAM METCALF, for paper "Steel: Its Properties; Its Use in Structures and in Heavy Guns." Vol. XVI,† p. 283.
1888. CLEMENS HERSCHEL, for paper "The Venturi Water Meter: An Instrument Making Use of a New Method of Gauging Water; Applicable to the Cases of Very Large Tubes, and of a Small Value Only, of the Liquid to be Gauged." Vol. XVII,† p. 228.
1889. JAMES D. SCHUYLER, for paper "The Construction of the Sweetwater Dam." Vol. XIX,† p. 201.
1890. O. CHANUTE, JOHN F. WALLACE and WILLIAM H. BREITHAUPT, for paper "The Sibley Bridge." Vol, XXI,† p. 97.
1891. WILLIAM H. BURR, for paper "The River Spans of the Cincinnati and Covington Elevated Railway, Transfer and Bridge Company." Vol. XXIII,† p. 47.
1892. SAMUEL M. ROWE, STILLMAN W. ROBINSON and HENRY H. QUIMBY, for paper "Red Rock Cantilever Bridge." Vol. XXV,† p. 662.
1893. WILLIAM MURRAY BLACK, for paper "The Improvement of Harbors on the South Atlantic Coast of the United States." Vol. XXIX,† p. 223.
1894. DAVID L. BARNES, for paper "Distinctive Features and Advantages of American Locomotive Practice." Vol. XXIX,† p. 385.
1895. WILLIAM R. HILL, for paper "The Water-Works of Syracuse, N. Y." Vol. XXXIV,† p. 23.
1896. H. ST. L. COPPÉE, for paper "Bank Revetment on the Lower Mississippi." Vol. XXXV,† p. 141.
1897. ARTHUR L. ADAMS, for paper "The Astoria (Oregon) City Water-Works." Vol. XXXVI,† p. 1.
1898. HENRY GOLDMARK, for paper "The Power Plant, Pipe Line and Dam of the Pioneer Electric Power Company at Ogden, Utah." Vol. XXXVIII,† p. 246.
1899. R. S. BUCK, for paper "The Niagara Railway Arch." Vol. XL,† p. 125.
1900. ALLEN HAZEN, for paper "The Albany Water Filtration Plant." Vol. XLIII,† p. 244.
1901. L. G. MONTONY, for paper "The Ninety-Sixth Street Power Station of the Metropolitan Street Railway Company, of New York City." Vol. XLIV,† p. 119.
1902. WILLIAM W. HARTS, for paper "Description of Coos Bay, Oregon, and the Improvement of Its Entrance by the Government." Vol. XLVI,† p. 482.
1903. GEORGE W. FULLER, for paper "The Filtration Works of the East Jersey Water Company, at Little Falls, New Jersey." Vol. L,† p. 394.
1904. GEORGE CECIL KENYON, for paper "Dock Improvements at Liverpool." Vol. LII,† p. 36.
1905. CHARLES L. HARRISON and SILAS H. WOODARD, for paper "Lake Cheesman Dam and Reservoir." Vol. LIII,† p. 89.
1906. GEORGE B. FRANCIS and W. F. DENNIS, for paper "The Scranton Tunnel of the Lackawanna and Wyoming Valley Railroad." Vol. LVI,† p. 219.

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* This prize was known as the Rowland Prize from 1883 to 1896 and consisted of $50. Beginning with the award for 1897 it is to be known as the Thomas Fitch Rowland Prize and consists of $60, with an engraved certificate signed by the President and Secretary of the Society.
† *Transactions*, Am. Soc. C. E.

1907. James D. Schuyler, for paper "Recent Practice in Hydraulic-Fill Dam Construction." Vol. LVIII,† p. 196.

1908. Edward E. Wall, for paper "Water Purification at St. Louis, Mo." Vol. LX,† p. 170.

1909. William J. Wilgus, for paper "The Electrification of the Suburban Zone of the New York Central and Hudson River Railroad in the Vicinity of New York City." Vol. LXI,† p. 73.

1910. John H. Gregory, for paper "The Improved Water and Sewage Works of Columbus, Ohio." Vol. LXVII,† p. 206.

AWARDS OF THE COLLINGWOOD PRIZE FOR JUNIORS

1895. Morton L. Byers, for paper "The Removal of the Channel Pier of the Cincinnati and Muskingum Valley Railway Bridge over the Scioto River." Vol. XXXI,† p. 361.

1896. Herbert Waldo York, for paper "The Twenty-Eighth Street Central Station of the United Electric Light and Power Company." Vol. XXXV,† p. 429.

1899. Julius Kahn, for paper "The Coal Hoists of the Calumet and Hecla Mining Company." Vol. XLI,† p. 269.

1900. Robert P. Woods, for paper "Street Grades and Cross-Sections in Asphalt and Cement." Vol. XLII,† p. 1.

1901. F. A. Kummer, for paper "A Proposed Method for the Preservation of Timber." Vol. XLV,† p. 181.

1903. Isaac Harby, for paper "The Footbridge for Building the Cables of the New East River Bridge." Vol. XLIX,† p. 165.

1904. Herbert J. Wild, for paper "The Substructure of Marsh River Bridge." Vol. LII,† p. 451.

1905. E. P. Goodrich, for paper "Lateral Earth Pressures and Related Phenomena." Vol. LIII,† p. 272.

1908. D. W. Krellwitz, for paper "Reinforced Concrete Towers." Vol. LX,† p. 160.

1909. H. L. Wiley, for paper "The Sinking of the Piers for the Grand Trunk Pacific Bridge at Fort William, Ontario, Canada." Vol. LXII,† p. 113.

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† *Transactions*, Am. Soc. C. E.

LOCATION AND DATE
OF
ANNUAL CONVENTIONS

Number.	Location.	Date.	
First,	New York, N. Y.,	June,	1869
Second,	New York, N. Y.,	June,	1870
Third,	New York, N. Y.,	June,	1871
Fourth,	Chicago, Ill.,	June,	1872
Fifth,	Louisville, Ky.,	May,	1873
Sixth,	New York, N. Y.,	June,	1874
Seventh,	Pittsburg, Pa.,	June,	1875
Eighth,	Philadelphia, Pa.,	June,	1876
Ninth,	New Orleans, La.,	April,	1877
Tenth,	Boston, Mass.,	June,	1878
Eleventh,	Cleveland, Ohio,	June,	1879
Twelfth,	St. Louis, Mo.,	May,	1880
Thirteenth,	Montreal, Que., Canada,	June,	1881
Fourteenth,	Washington, D. C.,	May,	1882
Fifteenth,	St. Paul and Minneapolis, Minn.,	June,	1883
Sixteenth,	Buffalo, N. Y.,	June,	1884
Seventeenth,	Deer Park, Md.,	June,	1885
Eighteenth,	Denver, Colo.,	July,	1886
Nineteenth,	Hotel Kaaterskill, N. Y.,	July,	1887
Twentieth,	Milwaukee, Wis.,	June,	1888
Twenty-first,	Seabright, N. J.,	June,	1889
Twenty-second,	Cresson, Pa.,	June,	1890
Twenty-third,	Lookout Mountain, Tenn.,	May,	1891
Twenty-fourth,	Old Point Comfort, Va.,	June,	1892
Twenty-fifth,	Chicago, Ill.,	July,	1893
Twenty-sixth,	Niagara Falls, N. Y.,	June,	1894
Twenty-seventh,	Hotel Pemberton, Hull, Mass.,	June,	1895
Twenty-eighth,	San Francisco, Cal.,	June,	1896
Twenty-ninth,	Quebec, Que., Canada,	June,	1897
Thirtieth,	Detroit, Mich.,	July,	1898
Thirty-first,	Cape May, N. J.,	June,	1899
Thirty-second,	London, England,	July,	1900
Thirty-third,	Niagara Falls, N. Y.,	June,	1901
Thirty-fourth,	Washington, D. C.,	May,	1902
Thirty-fifth,	Asheville, N. C.,	June,	1903
Thirty-sixth,	St. Louis, Mo.,	October,	1904
Thirty-seventh,	Cleveland, Ohio,	June,	1905
Thirty-eighth,	Frontenac, Thousand Islands, N. Y.,	June,	1906
Thirty-ninth,	City of Mexico, Mexico,	July,	1907
Fortieth,	Denver, Colo.,	June,	1908
Forty-first,	Bretton Woods, N. H.,	July,	1909
Forty-second,	Chicago, Ill.,	June,	1910

LIST OF MEMBERS

AUTHORIZED ABBREVIATIONS

HONORARY MEMBER	Hon. M. Am. Soc. C. E.
MEMBER	M. Am. Soc. C. E.
ASSOCIATE MEMBER	Assoc. M. Am. Soc. C. E.
ASSOCIATE	Assoc. Am. Soc. C. E.
JUNIOR	Jun. Am. Soc. C. E.
FELLOW	F. Am. Soc. C. E.

The Board of Direction requests the use of these abbreviations in all cases.

The awards of the Norman Medal, the Thomas Fitch Rowland Prize, and the Collingwood Prize for Juniors, are indicated in this list by the letters N., R., and C., respectively, prefixed to the name of each recipient.

It is particularly requested that every
change of address
be communicated immediately to:
The Secretary, American Society of Civil Engineers,
220 West Fifty-seventh Street,
New York, N. Y.

PAST-PRESIDENTS

James Laurie	Nov. 5, 1852, to Nov. 6, 1867.
James Pugh Kirkwood	Nov. 6, 1867, to Aug. 5, 1868.
William Jarvis McAlpine	Aug. 5, 1868, to Nov. 3, 1869.
Alfred Wingate Craven	Nov. 3, 1869, to Nov. 1, 1871.
Horatio Allen	Nov. 1, 1871, to Nov. 5, 1873.
Julius Walker Adams	Nov. 5, 1873, to Nov. 3, 1875.
George Sears Greene	Nov. 3, 1875, to Nov. 7, 1877.
Ellis Sylvester Chesbrough	Nov. 7, 1877, to Nov. 6, 1878.
William Milnor Roberts	Nov. 6, 1878, to Nov. 5, 1879.
Albert Fink	Nov. 5, 1879, to Nov. 3, 1880.
James Bicheno Francis	Nov. 3, 1880, to Jan. 18, 1882.
Ashbel Welch	Jan. 18, 1882, to Sept. 25, 1882.*
Charles Paine	Jan. 17, 1883, to Jan. 16, 1884.
DON JUAN WHITTEMORE	Jan. 16, 1884, to Jan. 21, 1885.
Frederic Graff	Jan. 21, 1885, to Jan. 20, 1886.
Henry Flad	Jan. 20, 1886, to Jan. 19, 1887.
William Ezra Worthen	Jan. 19, 1887, to Jan. 18, 1888.
THOMAS COLTRIN KEEFER	Jan. 18, 1888, to Jan. 16, 1889.
Max Joseph Becker	Jan. 16, 1889, to Jan. 15, 1890.
William Powell Shinn	Jan. 15, 1890, to Jan. 21, 1891.
Octave Chanute	Jan. 21, 1891, to Jan. 20, 1892.
MENDES COHEN	Jan. 20, 1892, to Jan. 18, 1893.
William Metcalf	Jan. 18, 1893, to Jan. 17, 1894.
William Price Craighill	Jan. 17, 1894, to Jan. 16, 1895.
George Shattuck Morison	Jan. 16, 1895, to Jan. 15, 1896.
Thomas Curtis Clarke	Jan. 15, 1896, to Jan. 20, 1897.
BENJAMIN MORGAN HARROD	Jan. 20, 1897, to Jan. 19, 1898.
Alphonse Fteley	Jan. 19, 1898, to Jan. 18, 1899.
DESMOND FITZGERALD	Jan. 18, 1899, to Jan. 17, 1900.
JOHN FINDLEY WALLACE	Jan. 17, 1900, to Jan. 16, 1901.
John James Robertson Croes	Jan. 16, 1901, to Jan. 15, 1902.
ROBERT MOORE	Jan. 15, 1902, to Jan. 21, 1903.
ALFRED NOBLE	Jan. 21, 1903, to Jan. 20, 1904.
Charles Hermany	Jan. 20, 1904, to Jan. 18, 1905.
CHARLES CONRAD SCHNEIDER	Jan. 18, 1905, to Jan. 17, 1906.
FREDERIC PIKE STEARNS	Jan. 17, 1906, to Jan. 16, 1907.
GEORGE HENRY BENZENBERG	Jan. 16, 1907, to Jan. 15, 1908.
CHARLES MACDONALD	Jan. 15, 1908, to Jan. 20, 1909.
ONWARD BATES	Jan. 20, 1909, to Jan. 19, 1910.
JOHN ANDERSON BENSEL	Jan. 19, 1910, to Jan. 18, 1911.

In this list, the names of deceased Past-Presidents are printed in italics.

* Mr. Ashbel Welch died September 25, 1882, during his term of office as President.

OFFICERS, 1911

PRESIDENT

MORDECAI T. ENDICOTT

VICE-PRESIDENTS

Term expires January, 1912

*—————— **HUNTER McDONALD**

Term expires January, 1913

ALFRED P. BOLLER **CHARLES L. STROBEL**

SECRETARY

CHARLES WARREN HUNT

TREASURER

JOSEPH M. KNAP

DIRECTORS

Term expires January, 1912

FRANCIS LEE STUART, SAMUEL C. THOMPSON, WILLIAM G. WILKINS,
ARTHUR N. TALBOT, WILLIAM M. GARDNER, HORACE A. SUMNER.

Term expires January, 1913

WILLIAM E. BELKNAP, HORACE LOOMIS, GEORGE A. KIMBALL,
PERCIVAL ROBERTS, Jr., CHARLES F. LOWETH, ARTHUR DeWINT FOOTE.

Term expires January, 1914

GEORGE C. CLARKE, HENRY G. STOTT, JONATHAN P. SNOW, ROBERT RIDGWAY,
LEONARD W. RUNDLETT, WILLIAM H. COURTENAY.

PAST-PRESIDENTS

(Members of the Board)

FREDERIC P. STEARNS, GEORGE H. BENZENBERG, CHARLES MACDONALD,
ONWARD BATES, JOHN A. BENSEL.

ASSISTANT SECRETARY

THOMAS J. McMINN

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* Vice-President John T. Fanning died February 6th, 1911.

Standing Committees of the Board of Direction

The President is *ex-officio* a member of all committees

On Finance

HENRY G. STOTT

ARTHUR N. TALBOT
GEORGE A. KIMBALL

HORACE LOOMIS
WILLIAM G. WILKINS

On Publications

WILLIAM E. BELKNAP

ROBERT RIDGWAY
GEORGE C. CLARKE

FRANCIS LEE STUART
CHARLES L. STROBEL

On Library

ALFRED P. BOLLER

JONATHAN P. SNOW
—————————— *

CHARLES F. LOWETH
CHARLES WARREN HUNT

Special Committees

On Uniform Tests of Cement

GEORGE S. WEBSTER

RICHARD L. HUMPHREY
GEORGE F. SWAIN
ALFRED NOBLE
LOUIS C. SABIN

S. B. NEWBERRY
CLIFFORD RICHARDSON
W. B. W. HOWE
F. H. LEWIS

On Concrete and Reinforced Concrete

J. R. WORCESTER

J. E. GREINER
W. K. HATT
OLAF HOFF

ROBERT W. LESLEY
EMIL SWENSSON
A. N. TALBOT

RICHARD L. HUMPHREY

On Engineering Education

DESMOND FITZGERALD

BENJAMIN M. HARROD
ONWARD BATES

D. W. MEAD
CHARLES HANSEL

On Steel Columns and Struts

AUSTIN L. BOWMAN

ALFRED P. BOLLER
EMIL GERBER
CHARLES F. LOWETH
RALPH MODJESKI
FRANK C. OSBORN

GEORGE H. PEGRAM
LEWIS D. RIGHTS
GEORGE F. SWAIN
EMIL SWENSSON
JOSEPH R. WORCESTER

On Bituminous Materials for Road Construction

W. W. CROSBY
A. W. DEAN

H. K. BISHOP
A. H. BLANCHARD

---

* Vacancy due to the death of Vice-President John T. Fanning.

CLASSIFIED LIST.

HONORARY MEMBERS.

[Hon. M. Am. Soc. C. E.]

	Date of Membership
Davidson, George. Prof. of Geography, Univ. of California, San Francisco, Cal.	May 5, 1897
Fox, *Sir* Douglas. Cross Keys House, 56 Moorgate St., London, E. C., England. (*Cor. M., June 7, 1871*)	Mar. 5, 1901
Fritz, John. 155 Market St., Bethlehem, Pa. (*M., July 5, 1893*)	Sept. 5, 1899
Gray, George Edward. Cons. Engr., 2945 Magnolia St., Glenwood Park, Berkeley, Cal. (*M., July 2, 1873*)	June 5, 1894
Mackenzie, Alexander. Retired Chf. of Engrs. and Maj.-Gen., U. S. A., The Birmingham, 2611 Adams Mill Rd., Washington, D. C. (*M., Feb. 2, 1887*)	May 12, 1905
Melville, George Wallace. Rear-Admiral, U. S. N. (*Retired*), 532 Walnut St. (Res., 620 North 18th St.), Philadelphia, Pa.	Dec. 20, 1899
Mills, Hiram Francis. Engr. of Proprietors of Locks and Canals on Merrimac River, Lowell, Mass.	Nov. 30, 1909
White, *Sir* William Henry. 8 Victoria St., Westminster, London, S. W., England	Dec. 16, 1904
Whittemore, Don Juan. (*Past-President*). Cons. Engr., C., M. & St. P. Ry. Co., 222 Biddle St., Milwaukee, Wis. (*M., July 10, 1872*)	Jan. 6, 1911

Honorary Members, 9.

CORRESPONDING MEMBERS.

Gleim, Charles Otto. Civ. and Cons. Engr., 184 Dorotheenstrasse, Hamburg, Germany	April 5, 1876
Pontzen, Ernest. 65 Rue de Monceau, Paris, France	Jan. 5, 1876

Corresponding Members, 2.

MEMBERS.

[M. Am. Soc. C. E.]

		Date of Membership
	Abbot, Frederic Vaughan. Col., Corps of Engrs., U. S. A., U. S. Engr. Office, 25 Pemberton Sq., Room 1017, Boston, Mass.	Dec. 3, 1884
	Abbot, Frederick William. Dongan Hills, N. Y. (*Assoc. M., Oct. 7, 1891*)	April 1, 1896
	Abbott, Edward Lorenzo. 71 Broadway, New York City. (*Jun., Sept. 1, 1886; Assoc., April 30, 1895*)	Mar. 6, 1906
	Abbott, Elizur Tavarro. Gen. Mgr., Klamath Lake R. R. Co., Pokegama, Ore.	Oct. 7, 1908
	Abbott, Fred Walter. 1328 Chestnut St., Philadelphia, Pa.	Sept. 7, 1904
	Ackerman, John Walter. Cons. Municipal Engr. and Supt. of the Municipal Water-Works System, Auburn, N. Y. (*Assoc. M., Sept. 6, 1905*)	Jan. 7, 1908
	Adam, Robert. 4ª Calle Humboldt 35, City of Mexico, D. F., Mexico	May 2, 1900
R.	**Adams, Arthur Lincoln.** Cons. Hydr. Engr., Balboa Bldg., San Francisco, Cal.	Oct. 2, 1895
	Adams, Edwin Griggs, Jr. Waverly, N. Y. (*Assoc. M., Jan. 1, 1896*)	Jan. 31, 1905
	Adams, Frederick. S. Pearson & Son, 2ª Puente de Alvarado 53, City of Mexico, D. F., Mexico	July 9, 1906
	Adams, Henry Sewall. 108 Ames Bldg., Boston, Mass.	June 6, 1906
	Affelder, Louis Jacob. Contr. Mgr., Am. Bridge Co. of N. Y., Frick Bldg., Pittsburg, Pa. (*Jun., Feb. 4, 1896; Assoc. M., June 5, 1901*)	June 5, 1906
	Africa, James Murray. Cons. Engr.; City Engr., Huntingdon, Pa.	Sept. 2, 1896
	Ahern, Jeremiah. Dixon, Cal.	May 4, 1904
	Aiken, William Augustin. Vice-Pres., Henry S. Spackman Eng. Co., 42 North 16th St., Philadelphia, Pa.	Oct. 2, 1889
	Aims, Walton Irving. 45 Broadway, New York City	May 4, 1904
	Alber, Hermann. 218 West Sunset Boulevard, Hollywood, Cal.	Dec. 6, 1905
	Albertson, Charles. 529 Market St., Bangor, Pa. (*Jun., Oct. 1, 1895; Assoc. M., Mar. 1, 1899*)	Oct. 7, 1903
	Alden, Charles Ames. Street Ry. Engr. of F. and S. Dept., Penn. Steel Co., Steelton, Pa. (*Assoc. M., May 4, 1898*)	Sept. 6, 1904
	Alden, Herbert Clarendon. Asst. Engr., Bureau of Sewers, 1518 Purdy St., Borough of Bronx, New York City. (*Assoc. M., Mar. 1, 1893*)	Feb. 2, 1909
	Alden, John Ferris. Cons. Engr., Rochester, N. Y.	July 6, 1887
	Alderman, Charles Aldo. Chf. Engr., Buffalo & Lake Erie Traction Co., 535 Brisbane Bldg., Buffalo, N. Y. (*Assoc. M., April 6, 1898*)	April 2, 1902
	Alderman, Clarence Edson. With Richardson, Barolt & Richardson, Archts., 31 State St., Boston, Mass. (*Assoc. M., Sept. 6, 1905*)	Mar. 2, 1909
	Aldrich, Truman Heminway. Room 1007, Brown Marx Bldg., Birmingham, Ala.	May 4, 1881
	Alfred, Frank Hooker. Gen. Supt., C., H. & D. Ry., Carew Bldg., Cincinnati, Ohio	June 3, 1903
	Alison, Thomas Henry. Care, Bergen Point Iron Works, Foot of West 5th St., Bayonne, N. J.	Oct. 7, 1908
	Allan, Percy. Pres., Hunter Dist. Water Supply and Sewage Board; Dist. Engr., Newcastle, New South Wales, Australia. (*Assoc. M., April 1, 1896*)	Oct. 1, 1902
	Allard, Thomas Throp. Chf. Engr. with Champion & Pascual, Contrs. and Engrs., 101 Obispo St., Havana, Cuba	Mar. 2, 1909
	Allen, Andrews. Contr. Engr., Wisconsin Bridge & Iron Co., 1127 Monadnock Bldg., Chicago, Ill.	Oct. 4, 1905
	Allen, C. Frank. Prof. of R. R. Eng., Mass. Inst. Tech., Boston, Mass.	Feb. 6, 1878
	Allen, Calvin Harlow. 1 West 72d St., New York City	Sept. 7, 1887
	Allen, Charles Albert. Cons. Engr., Station A, Worcester, Mass.	June 4, 1879
	Allen, Chauncey Loomis. Vice-Pres. and Gen. Mgr., Syracuse Rap. Trans. Ry. Co., Utica & Mohawk Val. Ry. Co., Oneida Ry. Co.; Pres., Syracuse & Suburban R. R. Co., Utica, N. Y.	Oct. 4, 1905
	Allen, Henry Clayton. City Engr., City Hall, Syracuse, N. Y. (*Assoc. M., July 1, 1891*)	Jan. 3, 1905
	Allen, James Pierson. Asst. Engr., U. S. Engr. Office, 8 Ladson St., Charleston, S. C. (*Jun., Mar. 5, 1879*)	June 4, 1884
	Allen, Kenneth. Engr., Met. Sewerage Comm. of New York, 17 Battery Pl., New York City	May 2, 1888
	Allen, Walter Hinds. Civ. Engr., U. S. N., Bureau of Yards and Docks, Navy Dept., Washington, D. C. (*Jun., May 1, 1900; Assoc. M., Nov. 4, 1903*)	Feb. 4, 1908

	Date of Membership
Allen, William Andrew. Supt. of Constr., The New River Collieries Co., Eccles, W. Va. (*Assoc. M., Feb. 6, 1901*)	Sept. 6, 1904
Allen, William Bullard. Mgr., Land Dept., Tennessee Coal, Iron & R. R. Co., 1314 Wancoma Ave., Birmingham, Ala	Feb. 3, 1904
Allin, Thomas David. 203 Kendall Bldg., Pasadena, Cal	Jan. 3, 1906
Almirall, Raymond Francis. Archt., 185 Madison Ave., New York City	Oct. 5, 1904
Alvord, John Watson. Hydr. and San. Engr., 1212 Hartford Bldg., Chicago, Ill	Jan. 4, 1893
Ambler, John Nicholas. Civ. and Hydr. Engr., Room 309, Masonic Temple, Winston-Salem, N. C	May 6, 1908
Ambursen, Nils Frederick. Vice-Pres. and Chf. Engr., Ambursen Hydr. Constr. Co., Boston, Mass	Jan. 8, 1908
Amweg, Frederick James, Advisory Engr. and Mgr. of Bldg. Operations, 700 Marston Bldg., San Francisco, Cal	Mar. 7, 1888
Andersen, Christian. 251 Twelfth St., Portland, Ore	Jan. 2, 1901
Anderson, David Guy. Cons. Engr., 4032 Walnut St., Philadelphia, Pa. (*Assoc. M., Oct. 4, 1899*)	May 3, 1910
Anderson, George Gray. Cons. Engr., 1232 First National Bank Bldg., Denver, Colo	Feb. 7, 1906
Anderson, Joshua Thomas Noble. Springbank, Narbethong, Victoria, Australia	Nov. 7, 1903
Anderson, William Pope. Pres. and Chf. Engr., The Ferro-Concrete Const. Co., Richmond and Harriet Sts., Cincinnati, Ohio	April 6, 1909
Andrews, Daniel Marshall. U. S. Asst. Engr., U. S. Engr. Office, Montgomery, Ala	Mar. 2, 1892
Andrews, David Herbert. Pres., The Boston Bridge Works, Inc., 38 Lake Ave., Newton Center, Mass	Sept 2, 1885
Andrews, Hiram Bertrand. 166 Devonshire St., Boston, Mass	Mar. 1, 1905
Andrews, Horace. 125 Lancaster St., Albany, N. Y	April 6, 1887
Andros, Frederic William. Chf. Engr., Nazas Val. & Pac. Ry., Tepehaunes, Durango, Mexico. (*Assoc. M., Feb. 1, 1899*)	Sept. 6, 1910
Angier, Walter Eugene. 1750 Monadnock Bldg., Chicago, Ill. (*Assoc. M., Sept. 7, 1892*)	Sept. 3, 1902
Annan, Charles Le Roy. Office Engr., Dept. of Public Works, St. Paul, Minn.	July 4, 1888
Anthony, Charles, Jr. Gen. Mgr., Bahia Blanca Water-Works Co., Casilla de Correo 149, Bahia Blanca, Argentine Republic	Mar. 5, 1902
Anthony, Charles Chapman. Asst. Signal Engr., P. R. R. Co., Broad St. Station, Philadelphia, Pa	Oct. 2, 1907
Appleton, Thomas. Supt. of Constr., U. S. Custom House, Room 144, Post Office Bldg., Boston, Mass	April 4, 1883
Arango, Ricardo Manuel. Chf. Engr. of the Republic of Panama, P. O. Box 140, Panama, Panama. (*Assoc. M., Sept. 2, 1896*)	Feb. 6, 1906
Archer, William. Gen. Office, B. & O. S. W. R. R., Cincinnati, Ohio	Mar. 2, 1881
Archibald, Peter Suther. Cons. Engr., Moncton, N. B., Canada	Jan. 7, 1885
Archibald, Warren Martin. Engr., M. of W., Houston Elec. Co., Houston, Tex. (*Assoc. M., May 2, 1906*)	Jan. 3, 1911
Arentz, Frederick Christian Holberg. Engr. and Contr., 627 Western Ave., Joliet, Ill. (*Assoc. M., May 6, 1891*)	Oct. 3, 1900
Argollo, Miguel de Teive e. Hotel Royal, 3 Singerstrasse, Vienna, Austria	Oct. 2, 1895
Armstrong, Alexander Floyd. Chf., Bureau of Research, State Dept. of Highways, Albany, N. Y. (*Jun., Oct. 7, 1902; Assoc. M., Nov. 1, 1905*).	Dec. 6, 1910
Armstrong, Walter Root. Supt., Mont. Div., Ore. Short Line R. R., Pocatello, Idaho	Oct. 4, 1905
Armstrong, William Coulson. Terminal Engr., C. & N. W. Ry. Co., 215 Jackson Boulevard, Room 804, Chicago, Ill	June 1, 1909
Arnold, Bion Joseph. 181 La Salle St., Chicago, Ill	Mar. 1, 1905
Arnold, William Harry. Gen. Mgr., Bay State Dredging Co., 185 Summer St., Room 804, Boston, Mass	May 1, 1907
Arthur, Howard Elmer. Chf. Engr., Mosher Mfg. Co., Dallas, Tex	Nov. 8, 1909
Artingstall, Samuel George. 117 South Hamilton Ave., Chicago, Ill	Oct. 6, 1886
Ash, Henry Clarke. Hydr. Engr., 15 Carlisle Ave., Hunters Park, Duluth, Minn	Oct. 3, 1906
Ash, Louis Russell. City Engr., Kansas City, Mo. (*Assoc. M., Dec. 5, 1906*)	Sept. 6, 1910
Ashbaugh, Lewis Eugene. Hydr. Engr., J. G. White & Co., 510 Alaska Commercial Bldg., San Francisco, Cal. (*Assoc. M., Jan. 7, 1903*)	May 5, 1908
Ashbridge, Richard I Downing. East Downingtown, Pa. (*Assoc. M., Sept. 3, 1902*)	April 30, 1907
Ashmead, Frank Milligan. Asst. to Prin. Asst. Engr., B. & A. V. Div., P. R. R., 428 Richmond Ave., Buffalo, N. Y	July 6, 1887
Ashmead, Percy Herbert. Cons. Engr., 43 Exchange Pl., New York City.	Mar. 6, 1907
Ashton, William. Chf. Engr., Ore. Short Line R. R., Salt Lake City, Utah.	May 6, 1908
Aspinwall, Thomas. 3 Hamilton Pl., Boston, Mass	May 2, 1888
Asserson, Henry Raymond. 495 Sixth St., Brooklyn, N. Y	Oct. 2, 1901
Atkinson, John Bond. Pres., St. Bernard Min. Co., Earlington, Ky	Sept. 5, 1877

	Date of Membership
Atterbury, William Wallace. Gen. Mgr., Penn. Lines East of Pittsburg and Erie, P. R. R., Broad St. Station, Philadelphia, Pa.	Mar. 2, 1909
Atwater, Almon Byron. Asst. to Pres., Grand Trunk Western Ry., Detroit, Mich.	May 5, 1886
Atwood, John Abiel. Chf. Engr., P. & L. E. R. R. Co., Pittsburg, Pa.	Jan. 3, 1900
Atwood, William Greene. Chf. Engr., L. E. & W. R. R., Indianapolis, Ind. (*Assoc. M., July 10, 1907*)	Nov. 1, 1910
Auchincloss, William S. Atlantic Highlands, N. J.	Feb. 17, 1869
Auryansen, Frederick. Bridge Engr., Long Island R. R., 44 Union Hall St., Jamaica, N. Y. (*Jun., Oct. 5, 1897; Assoc. M., Dec. 3, 1902*)	April 6, 1909
Aus, Gunvald. Cons. Engr., 11 East 24th St., New York City	April 3, 1895
Austin, William Eugene. Archt., 46 West 24th St., New York City	Dec. 7, 1904
Averill, Frank Lloyd. (Averill & Adams, Archts. and Engrs.), 719 Union Trust Bldg., Washington, D. C. (*Assoc. M., Jan. 6, 1897*)	May 6, 1903
Avery, Frederick Hague. 1457 Berwyn Ave., Chicago, Ill.	May 31, 1910
Axtell, Decatur. Vice-Pres., C. & O. Ry. Co.; Chairman, Board of Directors, Tol. & Ohio Cent. Ry. Co., Richmond, Va.	Mar. 3, 1886
Aycrigg, William Anderson. Cons. Engr., 102 Chambers St., New York City. (*Assoc. M., May 4, 1892*)	May 4, 1898
Ayres, Clarence Morton. Chf. Engr., Central Iron & Coal Co., 1208 Queen City Ave., Tuscaloosa, Ala. (*Assoc. M., Oct. 2, 1901*)	Oct. 31, 1905
Ayres, Willis Edward. Cons. and Const. Engr., Randolph Bldg., Memphis, Tenn.	May 31, 1910
Babb, Cyrus Cates. Dist. Engr., U. S. Geological Survey, Care, Maine State Water Storage Comm., Augusta, Me. (*Jun., Feb. 2, 1892; Assoc. M., Feb. 3, 1897*)	Mar. 1, 1904
Babcock, Henry Nash. U. S. Asst. Engr., Army Bldg., 39 Whitehall St., New York City	Sept. 3, 1884
Bachert, Augustus Ellsworth. Gen. Supt., Rockhill Iron & Coal Co.; Chf. Engr., East Broad Top R. R. Co., Tyrone, Blair Co., Pa.	June 3, 1908
Bacon, George Morgan. 159 Pierpont Ave., Salt Lake City, Utah. (*Assoc. M., Dec. 3, 1902*)	Dec. 5, 1905
Bacon, James Hayward. Prince Rupert, B. C., Canada	Jan. 3, 1900
Bacot, William Sinclair. 234 Genesee St., Utica, N. Y.	Oct. 1, 1890
Badenhausen, John Phillips. Advisory Engr., The Moran Co., 913 Am. Bank Bldg., Seattle, Wash.	Oct. 5, 1909
Baffrey, Charles Raymond. Pres., Hennebique Constr. Co., 1170 Broadway, New York City	Jan. 4, 1910
Bailey, William Melvin. Chf. Engr., Eastern Expanded Metal Co., Paddock Bldg., Boston (Res., Ridgewood Rd., Malden), Mass. (*Assoc. M., Sept. 5, 1900*)	Mar. 3, 1908
Baily, Thomas Chalkley James, Jr. 531 Randolph St., N. W., Washington, D. C.	Oct. 4, 1905
Baird, Howard Carter. Prin. Asst. Engr., Boller & Hodge, 149 Broadway, New York City. (*Jun., June 6, 1893; Assoc. M., Oct. 5, 1898*)	Feb. 2, 1904
Baird, Samuel Pond. Pres., Standard Brick Co., Charleston, W. Va. (*Assoc. M., Mar. 1, 1899*)	Sept. 4, 1906
Bakenhus, Reuben Edwin. Civ. Engr., U. S. N., U. S. Naval Stations, Cavite and Olongapo, Philippine Islands	Oct. 2, 1907
Baker, Charles Hinckley. Vice-Pres., Am. Cyanamid Co.; Vice-Pres., Muscle Shoals Hydro-Elec. Co., Mohegan Lake, N. Y.	June 4, 1902
Baker, Holland Williams. U. S. Asst. Engr., 235 South Highland Ave., Pittsburg, Pa.	May 7, 1890
Baker, Ira Osborn. Prof. of Civ. Engr., Univ. of Illinois, 702 West University Ave., Champaign, Ill.	May 3, 1893
Baker, Shirley. Mgr., Pipe Dept., Redwood Manufacturers Co., 916 Balboa Bldg., San Francisco, Cal. (*Jun., Sept. 11, 1900; Assoc. M., June 3, 1903*)	June 2, 1908
Baker, William Edgar. 105 West 40th St., New York City	June 1, 1898
Balch, William Hoyt. Ayudante Director, Direccion Genl. de Obras Publicas, Santo Domingo, Santo Domingo. (*Assoc. M., April 1, 1903*)	Dec. 3, 1907
Baldwin, Archibald Stuart. Chf. Engr., I. C. R. R., Chicago, Ill.	Dec. 6, 1905
Baldwin, Ernest Howard. Project Engr., U. S. Reclamation Service, Ellensburg, Wash. (*Assoc. M., May 4, 1898*)	Oct. 3, 1905
Baldwin, Fred Hixon. Supt., Bergenport Chemical Works, Bayonne, N. J.	Nov. 5, 1884
Baldwin, George Porter. Care, Gen. Elec. Co., Park Bldg., Pittsburg, Pa.	Feb. 5, 1908
Baldwin, Thomas Williams. Weston Rd., Wellesley, Mass.	April 2, 1884
Baldwin, Ward. Cons. Engr., 807 Commercial Tribune Bldg., Cincinnati, Ohio. (*Jun., Mar. 2, 1881*)	Oct. 2, 1889
Baldwin, William Henry. Warburton Bldg., Yonkers, N. Y.	June 6, 1888
Baldwin, William James. Cons. Heating and Ventilating Engr., World Bldg., New York City	Sept. 5, 1888
Ball, Charles Backus. Chf. San. Insp., Dept. of Health, 215 Madison St. (Res., 1951 Sunnyside Ave.), Chicago, Ill.	Oct. 1, 1890

	Date of Membership
Ballard, Robert. 35 Wood Lane, Shepherd's Bush, London, W., England.	Sept. 1, 1880
Ballinger, Walter Francis. 1211 Arch St., Philadelphia, Pa.	Feb. 7, 1906
Bamford, William Brokaw. Archt. and Cons. Engr., Trenton (Res., 614 Tenth Ave., Belmar), N. J. (*Jun., June 2, 1903; Assoc. M., Oct. 5, 1904*)	May 31, 1910
Barber, William Davis. Asst. Engr., Bureau of Eng., Dept. of Public Works, Chicago, Ill. (*Assoc. M., Sept. 1, 1897*)	Jan. 8, 1902
Barbour, Frank Alexander. Cons. Hydr. and San. Engr., 1120 Tremont Bldg., Boston, Mass.	Sept. 5, 1900
Barcroft, Frederick Thomas. Cons. Engr. and Archt., Suite 1728, Ford Bldg., Detroit, Mich.	Sept. 3, 1902
Bard, George Parker. New York Mgr., Petroleum Iron Works Co., 50 Church St., New York City	April 6, 1909
Bardol, Frank Valentine Erhard. Engr. and Contr., 400 D. S. Morgan Bldg., Buffalo, N. Y.	May 2, 1900
Barlow, John Quincy. Asst. Chf. Engr., Southern Pacific Co., 1120 Flood Bldg., San Francisco, Cal. (*Jun., April 7, 1886*)	July 4, 1888
Barnard, Edward Chester. Geographer, U. S. Geological Survey, Washington, D. C.	Dec. 3, 1902
Barnes, Edward Harding. Chf. Engr., G. R. & I. Ry., Grand Rapids, Mich.	Dec. 5, 1906
Barnes, Mortimer Grant. Member, Advisory Board of Cons. Engrs. for the Impvt. of State Canals, State Hall, Albany, N. Y. (*Assoc. M., Nov. 2, 1898*)	May 31, 1904
Barnes, Osgood Frost. Div. Engr., Erie R. R., Susquehanna, Pa.	June 30, 1910
Barnes, Thomas Howard. Care, United Fruit Co., 321 St. Charles St., New Orleans, La.	Oct. 4, 1899
Barnett, John William. City Engr., Athens, Ga.	Jan. 4, 1905
Barr, Joseph Carroll. Contr. Engr. (J. C. Barr Co.), Joplin, Mo. (*Assoc. M., Jan. 4, 1899*)	Nov. 1, 1910
Barragan, Mariano Melerio. 3ª de las Artes, No. 42, City of Mexico, Mexico	Feb. 5, 1908
Barrally, Thomas Webster. Div. Engr., Erie Canal, 45 Triangle Bldg., Rochester, N. Y.	Dec. 5, 1906
Barrows, Harold Kilberth. Associate Prof. of Hydr. Eng., Mass. Inst. Tech.; (Barrows & Breed, Cons. Engrs.), 6 Beacon St., Boston, Mass. (*Assoc. M., Jan. 6, 1904*)	Mar. 31, 1908
Bascom, Harry Franklin. (Bascom & Sieger), 603 Allentown Bank Bldg., Allentown, Pa. (*Jun., Dec. 5, 1899; Assoc. M., Sept. 4, 1901*)	Mar. 2, 1909
Basinger, James Garnett. 52 Broadway, New York City. (*Assoc. M., Oct. 3, 1900*)	April 30, 1907
Bassel, Robert. Regierungs und Bau-Rat, Lobauer Strasse 10. Deutsch-Eylau, Germany	May 2, 1888
Bassett, Carroll Phillips. Treas., Commonwealth Water & Light Co., Summit, N. J.	Nov. 7, 1888
Bassett, George Barclay. Pres. and Gen. Mgr., Buffalo Meter Co., Buffalo, N. Y.	Mar. 1, 1893
Bassett, John Benjamin. U. S. Asst. Engr., U. S. Engr. Office, Moline, Ill.	Dec. 1, 1908
BATES, ONWARD. (*Past-President*). 193 Michigan Boulevard, Chicago, Ill.	Jan. 4, 1882
Baucus, William I. Engr. in Chg. of Surveys and Investigations for U. S. Intra-Coastal Waterways Canal from Boston to Narragansett Bay, U. S. Engr. Office, 25 Pemberton Sq., Boston, Mass.	Oct. 7, 1908
Bauer, Jacob Louis. 130 Broad St., Elizabeth, N. J. (*Assoc. M., Feb. 5, 1896*)	June 1, 1909
Baum, George. 520 Warburton Ave., Yonkers. N. Y. (*Jun., Jan. 4, 1892; Assoc. M., April 5, 1899*)	Mar. 6, 1906
Baum, Harry William. Contr. Mgr., James Stewart & Co., First National Bank Bldg., Denver, Colo.	Oct. 4, 1910
Baxter, Frank Edwin. Vice-Pres., Baxter, Straw & Storrs Constr. Co., 1250 E. South Temple St., Salt Lake City, Utah	Oct. 2, 1901
Baxter, George Strong. Railroad and lumber business, 15 William St., New York City. (*Jun., May 12, 1875*)	May 3, 1876
Bayliss, John Yancey. Care, Madeira-Mamoré Ry. Co., Caixa 304, Manãos, Brazil. (*Assoc. M., Sept. 2, 1903*)	Sept. 1, 1908
Bayliss, Rawlinson Tennant. 11 Cornhill, London, E. C., England	June 4, 1890
Beach, Lansing Hoskins. Lt.-Col., Corps of Engrs., U. S. A., Room M, Custom House, New Orleans, La.	June 7, 1905
Beach, Robert James. Pres., R. J. Beach Eng. Co., 32 Broadway, New York City	May 2, 1900
Beahan, Willard. First Asst. Engr., L. S. & M. S. Ry., Room 50, Lake Shore Bldg., Cleveland, Ohio	April 3, 1889
Beard, Edward James. 3838 McGee St., Kansas City, Mo.	Feb. 7, 1900
Beardsley, Arthur. Emeritus Prof. of Eng., Swarthmore Coll., Swarthmore, Pa. (*Assoc., Sept. 1, 1875*)	Sept. 2, 1891
Beardsley, James Wallace. Chf. Engr., Irrig. Service, Guayama, Porto Rico	Dec. 4, 1901

MEMBERS B

	Date of Membership
Beattie, Roy Hamilton. Engr. and Contr., 57 North Main St., Fall River, Mass.	Oct. 5, 1909
Beatty, Philip Asfordby. Water Dept., Baltimore, Md. (*Assoc. M., Nov. 6, 1907*)	May 4, 1909
Beckwith, Frank. Missoula, Mont.	Nov. 7, 1900
Bedford, Thomas Archibald. Deputy Engr., San Diego County Highway Comm., 4640 Campus Ave., San Diego, Cal.	Sept. 6, 1910
Beeler, John Allen. Vice-Pres. and Gen. Mgr., The Denver City Tramway Co., 617 Majestic Bldg., Denver, Colo.	July 10, 1907
Behrend, Bernard Arthur. Advisory Engr., Westinghouse Elec. & Mfg. Co., and Engr. in Chg., Power Eng. Dept., P. O. Box 143, East Liberty, Pittsburg, Pa.	Oct. 5, 1909
Belden, Harry Austin. Capital Traction Co., Washington, D. C.	Oct. 4, 1905
Belknap, John Mansfield. Office Engr., Chf. Engr.'s Office, L. I. R. R. Co., Jamaica (Res., Manhasset), N. Y. (*Assoc. M., May 4, 1904*)	Mar. 31, 1908
BELKNAP, WILLIAM ETHELBERT. (*Director*). 294 West End Ave., New York City. (*Jun., Mar. 31, 1891; Assoc. M., Mar. 6, 1895*)	Dec. 1, 1897
Bell, Alonzo Clarence. Chf. Engr., Board of Commrs. of the Port of New Orleans, Suite 200, New Orleans Court Bldg., New Orleans, La.	Mar. 7, 1900
Bell, Andrew. Cons. Engr., Almonte, Ont., Canada	Sept. 5, 1883
Bell, George Joseph. County Surv. and Bridge Master, The Courts and 16 Portland Sq., Carlisle, England. (*Assoc. M., Nov. 2, 1898*)	Oct. 1, 1902
Bell, Gilbert James. Div. Engr., A., T. & S. F. Ry. Co., Marceline, Mo. (*Jun., Sept. 7, 1887*)	Oct. 6, 1897
Bell, James Richard. Hazeldene, Ightham, Kent, England	Sept. 2, 1896
Bellinger, Lyle Frederick. Civ. Engr., U. S. N., U. S. Navy Yard, Philadelphia, Pa.	Nov. 6, 1901
Bellows, Oscar Francis. Res. Engr., Barge Canal, 43 Triangle Bldg., Rochester, N. Y. (*Assoc. M., Dec. 4, 1901*)	May 1, 1906
Bement, Robert Bunker Coleman. Cons. and Contr. Engr.; Pres., Robinson & Cary Co., St. Paul, Minn.	Sept. 7, 1887
Benedict, Herschel Albert. Mech. Engr., Public Service Ry. Co., Newark, N. J.	Mar. 2, 1909
Bennett, Frederick Wagoner. Cape May Court House, N. J.	Oct. 7, 1903
Bennett, Samuel Givens. 228 So. Ave. 66, Los Angeles, Cal.	Oct. 3, 1906
BENSEL, JOHN ANDERSON. (*Past-President*). State Engr. and Surv., Albany, N. Y. (*Jun., Sept. 2, 1885*)	Mar. 4, 1891
Benson, Orville. Pequannock, N. J.	June 5, 1901
Bent, Cornelius Conway Felton. Vice-Pres., Staten Island Rapid Transit Ry., 17 State St., New York City	May 1, 1889
Bentzon, Adrian Benoni. Civ. Engr. and Contr., Calle Corcovado 408 Altos, Lima, Peru. (*Assoc. M., Mar. 6, 1901*)	Sept. 4, 1906
BENZENBERG, GEORGE HENRY. (*Past-President*). Cons. Engr., 1310 Wells Bldg., Milwaukee, Wis.	May 2, 1883
Bergen, Van Brunt. Shore Rd. and 77th St., Brooklyn, N. Y.	June 17, 1868
Berle, Kort. Cons. Engr., 11 East 24th St., New York City. (*Assoc. M., Dec. 6, 1899*)	Nov. 4, 1903
Berquist, Axel Samuel Frederick. 1571 Forty-seventh St., Brooklyn, N. Y.	June 6, 1906
Berry, George. Asst. Engr., Bureau of Highways, Municipal Bldg., Brooklyn, N. Y.	May 3, 1905
Berry, John Bennington. Chf. Engr., C., R. I. & P. Ry. Co., La Salle Station, Chicago, Ill.	May 4, 1909
Berry, Thomas. 1042 Locust Ave., Long Beach, Cal.	July 1, 1908
Bettes, Charles Robert. Chf. Engr., Queens County Water Co., Far Rockaway, N. Y. (*Jun., Oct. 1, 1890; Assoc. M., June 7, 1893*)	June 1, 1909
Betts, Fred Keeler. Div. Engr., Board of Water Supply, New York City, 293 Wall St., Kingston, N. Y.	May 4, 1898
Betts, Romeo Thompson. Asst. Engr., Dept., Docks and Ferries, Pier A, N. R., New York City. (*Assoc. M., Oct. 3, 1900*)	Feb. 2, 1909
Beugler, Edwin James. Civ. Engr., Westinghouse, Church, Kerr & Co., 10 Bridge St., New York City. (*Jun., June 19, 1891; Assoc. M., Feb. 1, 1899*)	Jan. 5, 1904
Biddle, John. Lt.-Col., Corps of Engrs., U. S. A., Chronicle Bldg., San Francisco, Cal.	July 4, 1894
Bienenfeld, Abel Morris. Chf. Engr., Associated Pipe Line Co., Wells-Fargo Bldg., 7th Floor, San Francisco, Cal.	Feb. 6, 1907
Bienenfeld, Bernard. Cons. Engr., 621 Wells-Fargo Bldg., San Francisco, Cal.	May 6, 1903
Bigelow, Edward Manning. Pittsburg, Pa.	Dec. 4, 1889
Billin, Charles Emery. 1113 Peoples Gas Bldg., Chicago, Ill. (*Jun., April 5, 1876*)	July 3, 1878
Billings, Asa White Kenney. Eng. Mgr., J. G. White & Co., Inc., 43 Exchange Place, New York City. (*Assoc. M., Dec. 5, 1906*)	Sept. 1, 1908
Binckley, George Sydney. Cons. Engr., 1108 Union Trust Bldg., Los Angeles, Cal.	April 5, 1910

	Date of Membership
Binkley, George Holland. Care, The Arnold Co., 181 La Salle St., Chicago, Ill.	Oct. 1, 1902
Bisbee, Fred Milton. Engr., Western Lines, A., T. & S. F. Ry., La Junta, Colo.	May 3, 1899
Bishop, Hubert Keeney. First Deputy, N. Y. State Highway Comm., Albany, N. Y.	Oct. 5, 1904
Bishop, William Israel. Pres., Bishop Constr. Co., Ltd., 3 Beaver Hall Sq., Montreal, Que., Canada. (*Assoc. M., Feb. 6, 1901*)	Oct. 2, 1906
Bissell, Clinton Spencer. Asst. Engr., P. R. R. Co., 60 Worthington St., Winfield Junction, N. Y.	May 6, 1908
Bissell, Frank Edward. Cons. Engr., 2185 East 93d St., Cleveland, Ohio. (*Jun., April 2, 1884*)	Sept. 2, 1891
Bissell, Hezekiah. Ponkapoag, Mass.	Sept. 15, 1869
Bixby, William Herbert. Brig.-Gen., Corps of Engrs., U. S. A., 508 Colorado Bldg., Washington, D. C.	April 5, 1882
Black, Alexander Leslie. 323 Baronne St., New Orleans, La.	Dec. 4, 1907
Black, William Murray. Col., Corps of Engrs., U. S. A., U. S. Engr. Office, Room 710, Army Bldg., New York City.	June 6, 1888
Blackford, Francis Webster. Civ. and Min. Engr., Avenida del Cinco de Mayo No. 32, Cuarto No. 406, City of Mexico, D. F., Mexico.	April 4, 1888
Blackwell, Francis Ogden. Cons. Engr., 49 Wall St., New York City.	Oct. 5, 1904
Blake, Carroll. 719 Chronicle Bldg., Houston, Tex. (*Assoc. M., May 3, 1905*)	May 5, 1908
Blakeley, George Henry. Structural Engr., Bethlehem Steel Co., 517 Seneca St., South Bethlehem, Pa. (*Jun., Dec. 4, 1889*)	Oct. 2, 1895
Blakeslee, Clarence. Civ. Engr. and Contr.; (C. W. Blakeslee & Sons), 58 Waverly St. (Res., 598 George St.), New Haven, Conn.	June 4, 1895
Blanchard, Arthur Horace. Associate Prof. of Civ. Eng., Brown University; Cons. Highway Engr., 171 Westminster St., Providence, R. I. (*Jun., Jan. 2, 1900; Assoc. M., April 5, 1905*)	May 4, 1909
Blanchard, Murray. Supt., The Foundation Co., 115 Broadway, New York City. (*Assoc. M., April 2, 1902*)	Dec. 6, 1910
Bland, George Pierrepont. 510 Harrison Bldg., Philadelphia, Pa. (*Jun., April 7, 1875*)	May 4, 1881
Bland, John Carlisle. Engr. of Bridges, Penn. Lines W. of Pitts., Union Station, Pittsburg, Pa. (*Jun., May 12, 1875*)	June 4, 1879
Blauvelt, Louis David. Chf. Engr., Denver, N. W. & Pac. Ry., 718 Majestic Bldg., Denver, Colo.	May 6, 1908
Blickle, Herman Renner. Secy. and Chf. Engr., Fort Pitt Bridge Works, Pittsburg, Pa.	Nov. 1, 1910
Blodgett, Albert Morrill. Pres., A. M. Blodgett Constr. Co., 217 Midland Bldg., Kansas City, Mo.	Sept. 7, 1904
Blodgett, John. Contr. Engr., Riverside Bridge Co., Martins Ferry, Ohio. (*Jun., Dec. 4, 1889; Assoc. M., Jan. 2, 1901*)	Nov. 1, 1910
Bloom, J George. Pres., Southern Ballast Co., Mill Creek, Okla.	July 9, 1906
Bloss, Richard Parkhurst. Mechanicsville, N. Y.	Jan. 6, 1904
Blossom, Francis. (Sanderson & Porter), 52 William St., New York City.	Dec. 4, 1907
Blum, Louis Philip. Asst. Engr., The W. G. Wilkins Co., 204 Broadway, North Side, Pittsburg, Pa.	May 31, 1910
Blunt, William Titcomb. 224 Rockingham St., Toledo, Ohio.	Oct. 5, 1898
Boardman, Charles Slauson. (Conkling & Boardman, Cons. Engrs.), 798 Ellicott Sq., Buffalo, N. Y.	Mar. 2, 1909
Body, John Benjamin. 2ª Puente de Alvarado 53, City of Mexico, D. F., Mexico. (*Assoc. M., Oct. 2, 1895*)	May 2, 1900
Boecklin, Werner. Cons. Engr., Dongan Hills, Borough of Richmond, N. Y. (*Jun., Mar. 1, 1892; Assoc. M., Dec. 1, 1897*)	Dec. 5, 1905
Bogart, John. Cons. Engr., 141 Broadway, New York City.	Feb. 17, 1869
Boggs, Edward Marshall. Chf. Civ. Engr., Oakland Traction Co., San Francisco, Oakland & San José Con. Ry., P. O. Box 496, Oakland, Cal.	June 6, 1900
Boggs, Frank Cranstoun. Capt., Corps of Engrs., U. S. A.; Gen. Purchasing Officer, Isthmian Canal Comm., Washington, D. C.	Nov. 8, 1909
Bogue, Virgil Gay. 15 William St., New York City.	Sept. 15, 1869
BOLLER, ALFRED PANCOAST. (*Vice-President*). Cons. Engr., 149 Broadway, New York City.	Dec. 4, 1867
Bolton, Channing Moore. Cons. Engr., Rio, Albemarle Co., Va.	Jan. 4, 1888
Bolton, Reginald Pelham. Cons. Engr., 527 Fifth Ave., New York City.	Sept. 6, 1899
Bond, Edward Austin. State Hall, Albany, N. Y.	Sept. 6, 1899
Bond, George Meade. Mech. Engr., 141 Washington St., Hartford, Conn.	Feb. 2, 1887
Bonnyman, Alexander. Chf. Engr. and Gen. Mgr., Atlanta, Birmingham & Atlantic R. R., A., B. & A. R. R. Bldg., Atlanta, Ga.	Nov. 4, 1908
Bontecou, Daniel. Cons. Engr., 406 Dwight Bldg., Kansas City, Mo.	Nov. 5, 1879
Bonzano, Adolphus. Pres., Bonzano Rail Joint Co., 331 South 18th St., Philadelphia, Pa.	Aug. 7, 1872
Bonzano, Maximilian Ferdinand. Fort Totten, N. Y.	Jan. 6, 1886
Booth, Arthur Allen. Civ. and Min. Engr., 1026 Twelfth Ave., West, Spokane, Wash.	June 30, 1910

	Date of Membership
Booth, George William. Chf. Engr., Committee on Fire Prevention, National Board of Fire Underwriters, 135 William St., New York City. (*Assoc. M., Sept. 7, 1904*)	Nov. 2, 1908
Booth, William Henry. 19 Chatsworth Rd., West Norwood, S. E., London, England	July 4, 1888
Boright, William Parsons. Chatham, N. Y. (*Jun., Jan. 2, 1894; Assoc. M., Mar. 1, 1899*)	Mar. 5, 1907
Bosler, Harry Sherman. Gen. Contr. (Bosler & Flynn), Chattanooga, Tenn.	Feb. 4, 1903
Bott, John B. Engr., P. R. R., Brownsville, Pa	Oct. 1, 1890
Bowen, Oscar Sidney. Res. Engr., G. N. Ry. Co., Spokane, Wash	May 4, 1909
Bower, Charles Phillip. Pres. of C. P. Bower Constr. Co., Gen. Contrs., Bulletin Bldg., Philadelphia, Pa	June 5, 1907
Bowers, George. City Engr., City Hall, Lowell, Mass	Oct. 1, 1902
Bowie, Augustus Jesse. 102-A Bluff, Yokohama, Japan	Nov. 1, 1882
Bowker, Willard Lewis. Walpole, Mass	June 3, 1903
Bowman, Austin Lord. Civ. and Cons. Engr., 165 Broadway, Room 2611, New York City. (*Assoc. M., Sept. 7, 1892*)	Dec. 1, 1897
Bowman, Charles Abel. Secy. and Treas., Morrison & Farrington, Inc., 514 Dillaye Bldg., Syracuse, N. Y	Nov. 1, 1905
Bowser, Edmund Hamilton. Chf. Timber Insp., Ill. Cent. R. R., 203 Rogers Bldg., Memphis, Tenn	June 1, 1904
Boyd, James Churchill. Cons. Engr., Westinghouse, Church, Kerr & Co., 10 Bridge St., New York City. (*Jun., Sept. 3, 1895; Assoc. M., May 1, 1901*)	Sept. 3, 1907
Boyd, William Charles. Asst. Engr., Pittsburg Rys. Co., 435 Sixth Ave., Pittsburg, Pa	Dec. 4, 1907
Boyden, Harry Chester. Care, H. C. Phillips, Chf. Engr., Santa Fe, Los Angeles, Cal	June 3, 1908
Boynton, George Herbert. Pres., Gen. Constr. Co., McManus Bldg., Davenport, Iowa	Sept. 3, 1884
Brace, James Henry. Secy. and Treas., Fraser, Brace & Co., 1328 Broadway, New York City. (*Assoc. M., Jan. 2, 1901*)	Sept. 6, 1904
Brackenridge, John Crosbie. Cons. Engr., 95 Liberty St., New York City.	May 5, 1897
Brackenridge, William Algernon. Vice-Pres. and Gen. Mgr., Southern California Edison Co., Los Angeles, Cal	June 2, 1886
Brackett, Dexter. Chf. Engr., Met. Water-Works, 1 Ashburton Pl., Boston, Mass	June 6, 1888
Bradbury, Edward Gatling. Civ. and San. Engr., 605 New Hayden Bldg., Columbus, Ohio. (*Assoc. M., Nov. 7, 1906*)	Aug. 31, 1909
Bradford, William. Cons. Engr., 909 Empire Bldg., Pittsburg, Pa	Dec. 7, 1898
Bradley, Daniel Edward. Berlin, Conn	May 1, 1895
Bradley, Frank Edward. 491 Fifth Ave., New York City	Feb. 6, 1907
Brady, Samuel Dunlap. Chf. Engr., Little Kanawha Syndicate Lines, Morgantown, W. Va	Sept. 7, 1904
Brainard, Owen. Cons. Engr.; Chf. Engr., Carrere & Hastings, Archts., 225 Fifth Ave., New York City	Oct. 3, 1906
Bramwell, George Washington. Cons. Engr., 335 Broadway, New York City	Mar. 1, 1893
Branch, Ernest William. Civ. and San. Engr., 947 Tremont Bldg., Boston, Mass	Sept. 6, 1905
Braxton, Jaquelin Marshall. U. S. Asst. Engr., U. S. Engr. Office, Jacksonville, Fla. (*Jun., Jan. 5, 1897; Assoc. M., May 3, 1899*)	Oct. 31, 1905
Brazer, George Herbert. (J. R. Worcester & Co., Cons. Engrs.), 79 Milk St., Boston, Mass. (*Assoc. M., Nov. 1, 1905*)	April 6, 1909
Breckinridge, William Lewis. Engr., M. of W., C., B. & Q. R. R., 209 Adams St., Chicago, Ill	Oct. 7, 1903
Breed, Oliver Clark. Cons. Civ. and Hydr. Engr., Fulton, N. Y	Sept. 6, 1910
Breen, John Edward. Prin. Asst. Engr., Bay Ridge Impvt., L. I. R. R., Church St., Richmond Hill, N. Y	May 1, 1907
R. Breithaupt, William Henry. (Keating & Breithaupt, Cons. Engrs.), 82 King St., East, Toronto, Ont., Canada. (*Jun., June 4, 1884*)	July 6, 1887
Bremner, George Hampton. Engr., Illinois Dist., C., B. & Q. R. R., 209 Adams St., Chicago, Ill	Dec. 6, 1899
Brendlinger, Peter Franklin. Civ. Engr. and Contr., 1009 Arcade Bldg., Philadelphia, Pa	Sept. 7, 1887
Brenneke, William George. (Brenneke & Fay, Cons. Civ. Engrs.), 1009 Fullerton Bldg., St. Louis, Mo. (*Assoc. M., Mar. 5, 1902*)	Jan. 2, 1906
Breuchaud, Jules. (Jules Breuchaud Constr. Co.), 290 Broadway (Res., The Belnord, Broadway and 86th St.), New York City. (*Assoc., June 5, 1889*)	Oct. 5, 1898
Brewer, Bertram. City Engr., Waltham, Mass	June 1, 1909
Brewster, Henry Baum. Engr., H. S. Kerbaugh, Inc., Contrs., Fairport, N. Y. (*Assoc. M., Mar. 6, 1907*)	Mar. 2, 1909
Briggs, Benjamin E. City Engr., City Hall, Erie, Pa	Nov. 4, 1908
Briggs, Josiah Ackerman. Cons. Engr., 150 Nassau St., New York City.	Sept. 1, 1886

	Date of Membership
BRIGGS, ROSWELL EMMONS. San Juan de Letran 41, City of Mexico, Mexico	Sept. 15, 1869
BRIGGS, WALDO CLAYTON. Chf. Engr., Degnon Realty & Terminal Impvt. Co., Long Island City, N. Y.	July 10, 1907
BRINCKERHOFF, ALEXANDER GORDON. Gen. Mgr., Johnson & Morris, 538 West 23d St., New York City (Res., 354 Jefferson Ave., Brooklyn, N. Y.)	Nov. 3, 1886
BRINSMADE, DANIEL SEYMOUR. Pres., The Ousatonic Water Co., Derby, Conn	Feb. 1, 1888
BRITT, DUDLEY DIGGES. Civ. and Min. Engr., Clarksburg, W. Va	April 1, 1908
BROHM, WILLIAM CARL. Chf. Engr., Grainger & Co. Iron Works, 100 Tenth St., Louisville, Ky	Feb. 1, 1905
BROOKS, FREDERICK. Secy., Assoc. Eng. Societies, 31 Milk St., Boston, Mass. *(Jun., June 7, 1876)*	Jan. 2, 1884
BROSIUS, ALBERT MARSHALL. First Asst. Engr., Baltimore Sewerage Comm., American Bldg., Baltimore, Md	Mar. 1, 1910
BROWN, BAXTER LAMONT. 610 Merchants-Laclede Bldg., St. Louis, Mo	April 1, 1903
BROWN, CHARLES CARROLL. Cons. Engr.; Editor, *Municipal Engineering Magazine,* 408 Commercial Club Bldg., Indianapolis, Ind	Oct. 2, 1895
BROWN, CHARLES OTTO. Cons. Engr., 624 Madison Ave., New York City. *(Jun., Jan. 6, 1875)*	Nov. 7, 1877
BROWN, EARL IVAN. Capt., Corps of Engrs., U. S. A., U. S. Engr. Office, Wilmington, N. C	Feb. 2, 1909
BROWN, FRANK DUDLY, City Engr., Shawnee, Okla	Oct. 4, 1910
BROWN, LE GRAND. Chf. Engr., Gen. Elec. Power Co. of California, 34 Ellis St., San Francisco, Cal	May 4, 1898
BROWN, LOUIS LIVINGSTON. Gen. Supt., The Foundation Co., 115 Broadway, New York City	May 3, 1905
BROWN, MAURICE FRITCHLEY. Chf. Engr., Boston Bridge Works, 47 Winter St., Boston, Mass. *(Assoc. M., Mar. 4, 1903)*	Feb. 28, 1905
BROWN, NORMAN FREED. 427 Atlantic Ave., Pittsburg, Pa. *(Assoc. M., June 5, 1907)*	Nov. 30, 1909
BROWN, PAUL GOODWIN. Managing Engr., The United Eng. & Contr. Co., 17 West 42d St., New York City	May 2, 1906
BROWN, PERRY FISHER. 300 Park View Terrace, Oakland, Cal	June 3, 1908
BROWN, RALPH HENRY. Chf. Engr., Eastern Bridge & Structural Co., Station A, Worcester, Mass	June 7, 1899
BROWN, ROBERT CALVIN. Evergreen Ave., Plainfield, N. J	Dec. 5, 1906
BROWN, STEPHEN PEARSON. Chf. Engr., The Tide Water Bldg. Co., and Thomas B. Bryson, 641 Fourth Ave., Brooklyn, N. Y. *(Assoc. M., Oct. 5, 1904)*	Nov. 1, 1910
BROWN, THOMAS ELLIS. Cons. Engr., Otis Elevator Co., 17 Battery Pl., New York City. *(Jun., Nov. 3, 1880)*	April 2, 1884
BROWN, WALTER HENRY. Hydr. Engr., Sierra & San Francisco Power Co., 85 Second St., San Francisco, Cal	May 31, 1910
BROWN, WENDELL PHILLIPS. Contr. Engr., King Bridge Co., Cleveland, Ohio. *(Assoc. M., Oct. 2, 1895)*	Mar. 5, 1902
BROWN, WILLIAM GERRIE. Cons. Engr., Chamber of Commerce, Portland, Ore	Nov. 7, 1906
BROWN, WILLIAM LOWE. Engr. of Underground Lines, Oficina del Subterraneo, F. C. Oeste, Buenos Aires, Argentine Republic. *(Assoc. M., Sept. 6, 1905)*	Oct. 1, 1907
BROWN, WILLIAM MAXWELL. Chf. Engr., Met. Sewerage Works, 1 Ashburton Pl., Boston, Mass	Feb. 5, 1896
BROWNE, GEORGE HAMILTON. Hawkwood, Zion, Louisa Co., Va	Sept. 3, 1884
BROWNE, JAMES SIMPSON. Div. Engr., N. Y., N. H. & H. R. R., 409 Union Station, Providence, R. I. *(Assoc. M., Oct. 4, 1893)*	July 1, 1909
BROWNELL, ERNEST HENRY. Civ. Engr., U. S. N., Navy Yard, Bremerton, Wash. *(Assoc. M., Jan. 1, 1896)*	Jan. 5, 1904
BROWNING, GEORGE ELLIOT. Chf. Engr., Cochin Govt., Rose Bank, Trichur, South India. *(Assoc. M., May 7, 1902)*	April 4, 1905
BROWNLEE, JAMES LEEMAN. Cons. Engr., 114 Liberty St., New York City	May 6, 1896
BRUCE, FRED WILLIAM. U. S. Asst. Engr., Jacksonville, Fla	April 4, 1900
BRUMLEY, DANIEL JOSEPH. Prin. Asst. Engr., Ill. Cent. R. R. Co., 1 Park Row, Chicago, Ill	June 3, 1908
BRUNER, ABRAHAM. Care, Norfolk & Western Ry., Roanoke, Va	Mar. 1, 1910
BRUNNER, JOHN. Asst. Gen. Supt., North Works, Illinois Steel Co., 1319 Wabansia Ave., Chicago, Ill	Mar. 2, 1898
BRYAN, CHARLES WALTER. Div. Contr. Mgr., Am. Bridge Co. of N. Y., 30 Church St., New York City	June 3, 1903
BRYAN, FRED ASDEL. Gen. Mgr., Ind. & Mich. Elec. Co., 220 Colfax Ave., South Bend, Ind	Dec. 1, 1908
BRYANT, BYRON HARKNESS. Chf. Engr., Mexico Northwestern Ry., Chihuahua, Chih., Mexico	Sept. 6, 1910
BRYDONE-JACK, ERNEST EDMUND. Prof. of Civ. Eng., Univ. of Manitoba, Winnipeg, Man., Canada. *(Assoc. M., Oct. 4, 1899)*	Oct. 6, 1908

		Date of Membership
	Bryson, Andrew. Pres., Brylgon Steel Casting Co., New Castle, Del.	April 1, 1885
	Buchanan, Edward Everett. Cons. Bridge Engr., Elmira, N. Y.	Dec. 4, 1889
	Buchholz, Carl Waldemar. Cons. Engr., Erie R. R., 50 Church St., New York City	Sept. 1, 1886
	Buck, Henry Robinson. (Buck & Sheldon, Inc., Cons. Engrs.), 60 Prospect St., Hartford, Conn. (*Jun., June 5, 1900; Assoc. M., Oct. 4, 1905*)	Feb. 4, 1908
R.	Buck, Richard Sutton. (Sanderson & Porter), 52 William St., New York City. (*Assoc. M., April 5, 1893*)	Mar. 2, 1898
	Buck, Waldo Emerson. Pres. and Treas., Worcester Mfrs. Mutual Insurance Co., 31 Institute Rd., Worcester, Mass.	July 3, 1889
	Budd, Robert Dunn. City Engr., Petersburg, Va.	Oct. 4, 1910
	Budge, Edward Barnard. Engr. in Chf., 1st Section, Chili State Rys., Chacabuco St. No. 13, Valparaiso, Chili	Nov. 6, 1901
	Budge, Enrique. Hôtel des Champs Elysées, 3 Rue Balzac, Paris, France	Feb. 1, 1882
	Buehler, Walter. Second Vice-Pres. and Cons. Engr., The Kettle River Co., 3041 Park Ave., Minneapolis, Minn. (*Assoc. M., Mar. 7, 1906*)	Jan. 4, 1910
	Buel, Emott Davis. Engr. for John Monks & Sons, 82 Beaver St., New York City	June 30, 1910
	Buffinton, Benjamin Thomas. 22 Bedford St., Fall River, Mass. (*Assoc. M., Sept. 7, 1904*)	Jan. 3, 1907
	Bull, George Mairs. Cons. Engr. (Bull & Witham), Foster Bldg., Denver, Colo.	Feb. 2, 1909
	Bullock, William Dexter. Asst. Engr. in Chg., Bridges and Harbor, City Engr.'s Office, Providence, R. I. (*Jun., Sept. 5, 1887*)	July 4, 1888
	Burbank, George Barker. 15 Wall St., New York City	July 4, 1888
	Burden, James. Res. Engr., New York State Barge Canal, Oswego, N. Y. (*Assoc. M., Feb. 5, 1902*)	Jan. 5, 1904
	Burdett, Frederick Anderson. Cons. Engr., 16 East 33d St., New York City. (*Jun., Feb. 2, 1897; Assoc. M., June 1, 1898*)	Oct. 7, 1903
	Burger, William Henry. Asst. Prof. of Civ. Eng., Coll. of Eng., Northwestern Univ., Box 174, Evanston, Ill.	Nov. 1, 1910
	Burgess, Alfred Samuel. Asst. Engr., New York Aqueduct Comm., 280 Broadway (Res., 1822 Anthony Ave.), New York City	Sept. 6, 1905
	Burgess, George Heckman. Chf. Engr., The Delaware & Hudson Co., Albany, N. Y. (*Jun., Feb. 1, 1898; Assoc. M., June 3, 1903*)	July 1, 1909
	Burgess, Harry. Maj., Corps of Engrs., U. S. A., 3338 St. Charles Ave., New Orleans, La.	Oct. 5, 1909
	Burke, Hubert Francis Daubeney. Director Gen. of Public Works, Dominican Republic, Santo Domingo, Santo Domingo	Feb. 1, 1910
	Burke, John Thomas. Caldwell, Idaho. (*Assoc. M., Nov. 1, 1905*)	Oct. 6, 1908
	Burke, Milo Darwin. Cons. Engr., Room 706, Second National Bank Bldg., Cincinnati, Ohio	July 4, 1894
	Burley, Harry Benjamin. 586 Newton St., Chestnut Hill, Brookline, Mass.	Mar. 4, 1908
	Burns, Clinton Sumner. Civ., Hydr. and San. Engr., 823 Scarritt Bldg., Kansas City, Mo. (*Assoc. M., Feb. 1, 1899*)	Jan. 3, 1905
	Burns, Edward Cook. 417 Spring St., Jamestown, N. Y.	July 5, 1882
	Burpee, Moses. Chf. Engr., Bangor & Aroostook R. R., Houlton, Me.	Sept. 3, 1884
	Burr, Edward. Lt.-Col., Corps of Engrs., U. S. A., Office of Chf. Engr., U. S. A., Washington, D. C.	May 6, 1891
R.	Burr, William Hubert. Cons. Engr.; Prof. of Civ. Eng., Columbia Univ., New York City. (*Jun., June 3, 1874; Assoc., May 5, 1880*)	Mar. 3, 1886
	Burrowes, Harry Gilbert. Res. Engr., Hudson & Manhattan R. R. Co., 124 West 31st St., New York City. (*Jun., Sept. 2, 1902; Assoc. M., Feb. 3, 1904*)	July 1, 1909
	Burt, Henry Jackson. Contr. Mgr., Am. Bridge Co. of N. Y., 1218 First National Bank Bldg., Denver, Colo.	Mar. 1, 1905
	Burton, Alfred Edgar. Dean and Prof. of Topographical Eng., Mass. Inst. Tech., Boston, Mass.	Sept. 4, 1901
	Bush, Edward Wallace, Chf. Engr., Saybrook and Lyme (Conn.) River Bridge Comm., Saybrook, Conn. (*Assoc. M., April 5, 1899*)	April 30, 1907
	Bush, Harry Dean. Vice-Pres. and Mgr., Baltimore Bridge Company, Baltimore, Md.	May 2, 1888
	Bush, Lincoln. Cons. Engr., 1 Madison Ave., New York City	Oct. 4, 1905
	Butcher, William Laramy. 2 Avon St., Cambridge, Mass. (*Assoc. M., May 4, 1904*)	Jan. 3, 1911
	Butler, Matthew Joseph. 2d Vice-Pres. and Gen. Mgr., Dominion Iron & Steel Co.; Dominion Coal Co.; Vice-Pres. and Gen. Mgr., Sydney Louisberg Ry. and Cumberland Coal & Ry. Co., Sydney, N. S., Canada	April 1, 1885
	Butterfield, Francis Eaves. Culiacan, Sinaloa, Mexico	Sept. 1, 1886
	Butts, Edward Pontany. Chf. Engr., Am. Writing Paper Co., Holyoke (Res., Springfield), Mass. (*Assoc. M., Feb. 2, 1898*)	Oct. 7, 1903
	Byam, Le Roy Henry. Asst. Engr., N. Y. C. & H. R. R. R. Co., 335 Madison Ave., New York City (Res., Edgecliff Terrace, Park Hill, Yonkers, N. Y.)	July 1, 1908
	Byers, Alexander Mosby Clayton. Supt., M. W., B. and B., Tehuantepec National Ry., Rincon Antonio, Oax., Mexico	Nov. 6, 1907

	Date of Membership
C. **Byers, Morton Lewis.** Chf. Engr., M. of W., Mo. Pac. System, Cor. 4th and Market Sts., St. Louis, Mo. (*Jun., Jan. 2, 1890*)	Sept. 7, 1898
Byllesby, Henry Manson. Pres., H. M. Byllesby & Co. (Inc.), Engrs., Am. Trust Bldg., Chicago, Ill	June 1, 1887
Cahill, Walter John. Chf. Engr. and Second Vice-Pres., Great Lakes Dredge & Dock Co., Chamber of Commerce (Res., 1030 E. 47th St.), Chicago, Ill	June 6, 1906
Cain, William. Prof. of Math., Univ. of North Carolina, Chapel Hill, N. C.	Nov. 7, 1888
Cairns, Robert Andrew. City Engr., Waterbury, Conn	Oct. 2, 1895
Calderwood, Isaac Glidden. Massena, N. Y	June 1, 1909
Caldwell, George Bowers. Engr., Westinghouse, Church, Kerr & Co., 10 Bridge St., New York City (Res., 54 Van Sice Ave., Yonkers, N. Y.)	April 1, 1908
Caldwell, William Howell. Room 501, Curry Bldg., Tampa, Fla	May 4, 1909
Callaghan, John. Box 1603, Edmonton, Alta., Canada	Oct. 3, 1906
Camp, Walter Mason. Chf. Editor, *Railway and Engineering Review*, 7740 Union Ave., Chicago, Ill	May 1, 1901
Campbell, John Logan. Engr., M. of W., El Paso & Southwestern R. R., El Paso, Tex	May 1, 1901
Campen, George Linden. Asst. City Engr., Omaha, Nebr	Oct. 5, 1909
Campion, Horace Thomas. Pres., The Campion McClellan Co., 1218 Chestnut St., Philadelphia, Pa	July 1, 1909
Canals, José Antonio. Civ. Engr. and Archt., 16 Tetuan St., San Juan, Porto Rico	May 3, 1905
Canfield, Edward. Gen. Supt., N. Y., O. & W. Ry., Middletown, N. Y	Dec. 3, 1879
Cannon, Madison Mott. Care, W. L. Miller, 19 Milk St., Boston, Mass	Jan. 2, 1907
Cantine, Edward Ike. Div. Engr., D., L. & W. Ry., 77 Watson Ave., East Orange, N. J	May 3, 1905
Caples, Martin Joseph. Vice-Pres. and Gen. Mgr., Carolina, Clinchfield & Ohio Ry., Johnson City, Tenn. (*Assoc. M., Nov. 4, 1891*)	Oct. 4, 1899
Cappelen, Frederick William. Chf. Engr. and Gen. Mgr., Decarie Incinerator Co., Hopkins, Minn	April 3, 1895
Carlile, Thomas Jenks. Prin. Asst. Engr., L. I. R. R., Jamaica, N. Y. (*Jun., Mar. 3, 1896; Assoc. M., Mar. 6, 1901*)	Dec. 3, 1907
Carlin, Joseph Patrick. Secy. and Treas., P. J. Carlin Constr. Co., 16 East 23d St., New York City. (*Jun., Oct. 4, 1898; Assoc. M., Sept. 6, 1905*)	May 31, 1910
Carll, David Sylvanus. Second Vice-Pres. and Gen. Mgr., Capital Traction Co., Washington, D. C. (*Jun., Mar. 7, 1888; Assoc. M., July 1, 1891*)	Oct. 7, 1896
Carmalt, Laurance Johnson. 128 West 11th St., New York City	May 1, 1907
Carpenter, Allan Wadsworth. Engr. of Structures, N. Y. C. & H. R. R. R., 7th Floor, Grand Central Palace, New York City (Res., 68 Arthur St., Yonkers, N. Y.). (*Jun., Mar. 5, 1901; Assoc. M., April 1, 1903*)	Sept. 1, 1908
Carpenter, Charles Lincoln. Chf. Engr., and Gen. Mgr., Guantanamo & Western R. R., Guantanamo, Cuba	Dec. 6, 1905
Carpenter, George Ansel. City Engr., Pawtucket, R. I	May 7, 1902
Carr, Albert. 68 Carnegie Ave., East Orange, N. J. (*Assoc. M., Mar. 2, 1892*)	Oct. 7, 1903
Carr, Walter Frank. Chf. Engr., The Falk Co., Milwaukee, Wis	June 6, 1894
Carroll, Eugene. Chf. Engr. and Mgr., Butte Water Co., Butte, Mont. (*Jun., Jan. 4, 1888; Assoc. M., July 1, 1891*)	June 2, 1897
Carson, Howard Adams. Cons. Engr., 79 Glenwood St., Malden, Mass	Feb. 7, 1894
Carson, William Waller. Prof. of Civ. Eng., Univ. of Tennessee, 1705 Clinch Ave., Knoxville, Tenn	Nov. 2, 1892
Carter, Edward Carlos. Chf. Engr., C. & N. W. Ry., Chicago, Ill	April 4, 1888
Carter, Henry Hall. Pres., Met. Contr. Co., and Cons. Engr., 95 Milk St., Boston, Mass	May 7, 1890
Carter, J. Rivers. Birmingham, Ala	Feb. 3, 1892
Carter, Shirley. Asst. Engr., U. S. Engr. Dept., Norfolk, Va. (*Jun., May 31, 1892; Assoc. M., Oct. 5, 1898*)	Dec. 4, 1906
Carter, William J. Cons. Engr., 1315 Rockefeller Bldg., Cleveland, Ohio. (*Jun., Feb. 5, 1895; Assoc. M., Sept. 7, 1898*)	Nov. 1, 1904
Cartlidge, Charles Hopkins. Bridge Engr., C., B. & Q. R. R., 209 Adams St., Chicago, Ill	May 4, 1904
Cary, Edward Richard. Prof. of Geodesy and Railroad Eng., Rensselaer Polytechnic Inst., Troy, N. Y	April 2, 1902
Case, James Francis. Vice-Pres., Cuban Eng. & Contr. Co., Arsenal 2, Havana, Cuba	Jan. 6, 1904
Cattell, William Ashburner. Cons. Engr., Foxcroft Bldg., San Francisco, Cal. (*Assoc. M., May 6, 1891*)	Oct. 7, 1896
Chadbourn, William Hobbs, Jr. 16 Winchester St., Brookline, Mass. (*Jun., Dec. 3, 1890*)	Mar. 1, 1905
Chamberlain, Phillip William. Mgr., Chamberlain & Xirinachs, Guapiles, Costa Rica	Oct. 2, 1895

	Date of Membership
Chamberlin, Chester Harvey. Asst. Chf. Engr., Tex. & Pac. Ry., Dallas, Tex.	Oct. 5, 1904
Chambers, Frank Taylor. Civ. Engr., U. S. N., U. S. Navy Yard, Norfolk, Va. (*Assoc. M., April 6, 1898*)	Mar. 3, 1903
Chambers, Herbert James. (Hamilton & Chambers, Steel Engrs. and Contrs.), 29 Broadway, New York City. (*Assoc. M., Nov. 5, 1902*)	Jan. 3, 1911
Chambers, Ralph Hamilton. Care, The Foundation Co., 115 Broadway, New York City. (*Assoc. M., Dec. 1, 1897*)	April 5, 1904
Chapin, Loomis Eaton. Cons. Engr., 14 Central Savings Bank Bldg., Canton, Ohio. (*Jun., Dec. 3, 1884; Assoc. M., Sept. 7, 1892*)	Nov. 4, 1896
Chapleau, Samuel Jefferson. Res. Engr., Public Works Dept., Ottawa, Ont., Canada. (*Assoc. M., May 1, 1901*)	Jan. 31, 1905
Chapman, James Russell. 1712 Anacapa St., Santa Barbara, Cal.	Mar. 6, 1901
Chappell, Thomas Fenning. 215 West 125th St., New York City	Oct. 5, 1904
Chase, Charles Francis. Cons. Engr., 75 Westminster St., Providence, R. I.	Jan. 1, 1896
Chase, Charles Francis. Chf. Engr., Berlin Constr. Co., Berlin (Res., 241 West Main St., New Britain), Conn.	Feb. 5, 1902
Chase, Frank Lynton. Pres., The Central Contract & Finance Co., 821 Columbus Savings & Trust Bldg., Columbus, Ohio. (*Assoc. M., Nov. 4, 1896*)	Nov. 1, 1899
Chase, John Carroll. Cons. Engr., Derry Village, N. H.	Mar. 1, 1893
Chase, Marvin. Cons. Engr., Wapato Irrig. Co., Richmond Beach, Wash.	June 5, 1907
Cheever, Albert Safford. Supt., Fitchburg Div., B. & M. R. R., Boston, Mass.	June 7, 1893
Cheney, Herbert Neal. Engr. of Constr., Boston Consolidated Gas Co., Hilton St., Roxbury, Mass. (*Assoc. M., Feb. 6, 1907*)	Sept. 1, 1908
Chester, John Needels. (Chester & Fleming, Cons. Engrs.), Union Bank Bldg., Pittsburg, Pa. (*Jun., Dec. 6, 1892; Assoc. M., Dec. 5, 1894*)	Mar. 6, 1901
Chibas, Eduardo Justo. Cons. Engr. and Contr., Marina alta 4, Santiago de Cuba, Cuba. (*Jun., Mar. 31, 1891; Assoc. M., May 6, 1896*)	Jan. 3, 1900
Child, Stephen. 6 Beacon St., Room 217, Boston, Mass.	Oct. 5, 1898
Childs, James Edmund. Vice-Pres. and Gen. Mgr., N. Y., O. & W. Ry., 56 Beaver St., New York City	Dec. 4, 1878
Childs, Oliver W. City Bridge Engr., City Hall, St. Louis, Mo. (*Assoc. M., Sept. 5, 1900*)	Sept. 3, 1902
Chipman, Willis. (Chipman & Power), Mail Bldg., Toronto, Ont., Canada	June 6, 1888
Chittenden, Hiram Martin. Brig.-Gen., U. S. A. (*Retired*), 124 Fifteenth Ave., N., Seattle, Wash.	Feb. 7, 1900
Choate, Joseph Kittredge. Gen. Mgr., Otsego & Herkimer R. R., Cooperstown, N. Y.	May 4, 1909
Christian, George Lyon. Asst. Engr., Bureau of Sewers, Borough of the Bronx, East 177th St. and 3d Ave. (Res., East 238th St., Woodlawn), New York City. (*Assoc. M., Mar. 6, 1895*)	Oct. 3, 1905
Christie, George B. (Christie & Lowe, Civ. Engrs. and Contrs.), 171 La Salle St., Chicago, Ill.	Oct. 2, 1895
N. **Christie, James.** Cons. Engr., 100 Rochelle Ave., Wissahickon, Philadelphia, Pa.	May 7, 1873
Christie, William Wallace. Cons. Engr., Citizens Trust Bldg., Paterson, N. J.	June 3, 1908
Christy, George Lewis. 128 West 42d St., New York City. (*Jun., June 6, 1893; Assoc. M., Nov. 4, 1896*)	Jan. 31, 1905
Church, Charles Titus. 155 William St., Geneva, N. Y.	May 1, 1889
Church, Fred Bush. 10 Bridge St., New York City	June 3, 1908
Church, William Lee. Pres. and Cons. Engr., Ambursen Hydr. Constr. Co., 176 Federal St., Boston, Mass.	Feb. 6, 1907
Churchill, Charles Samuel. Chf. Engr., Norfolk & Western Ry., Roanoke, Va.	May 1, 1889
Churchill, John Charles. U. S. Asst. Engr., Oswego, N. Y.	Feb. 1, 1899
Clapp, Joseph Malcolm. Prin. Asst. Engr., U. S. Engr. Office, P. O. Box 1809, Seattle, Wash.	Nov. 4, 1908
Clapp, Otis Francis. City Engr., City Hall, Providence, R. I.	Mar. 2, 1898
Clapp, William Billings. Dist. Engr., Water Resources Branch, U. S. Geological Survey, Los Angeles (Res., 205 South Fair Oaks Ave., Pasadena), Cal.	Dec. 6, 1905
Clark, Charles Henry. Engr., M. of W., Cleveland Rys., Cleveland, Ohio.	May 7, 1902
Clark, George Hallett. Engr., Holbrook, Cabot & Rollins Corporation, Dry Dock No. 4, New York Navy Yard; Address, 301 West 109th St., New York City. (*Jun., Oct. 3, 1893; Assoc. M., Apr. 6, 1898*)	Oct. 31, 1905
Clark, Roscoe Nathaniel. Asst. City Engr., 800 Main St., Hartford, Conn. (*Assoc. M., May 4, 1904*)	Mar. 5, 1907
Clark, Thomas Stevens. Chf. Engr., Alphons Custodis Chimney Cons. Co., 622 Bennett Bldg., New York City	June 3, 1908
Clark, Watson Gerould. Tenafly, N. J.	July 9, 1906
Clarke, David Dexter. Engr., Water Board, Portland, Ore.	July 5, 1882

	Date of Membership
N. Clarke, Eliot Channing. 15 Brimmer St., Boston, Mass.	Sept. 4, 1878
Clarke, Ernest Wilder. Div. Engr., Board of Water Supply, City of New York, Pleasantville, N. Y.	Jan. 4, 1905
CLARKE, GEORGE CALBRAITH. (*Director*). Pennsylvania Terminal, 32d St. and 7th Ave., New York City	June 3, 1903
Clarke, St. John. Bogota, N. J. (*Jun., Sept. 5, 1888*)	June 1, 1904
Clarke, Thomas Curtis. Care, Lackawanna Steel Co., 2 Rector St., New York City	May 4, 1909
Clarkson, Robert Cooke. Care, Chas. E. Monday & Co., 1320 Olive St., Philadelphia, Pa. (*Jun., Jan. 5, 1887*)	Jan. 2, 1901
Claussen, Oscar. Cons. Engr., National German Am. Bank Bldg., St. Paul, Minn.	Oct. 2, 1901
Clayton, Robert Morris. City Engr., Atlanta, Ga.	Mar. 4, 1896
Clayton, Thomas Wiley. Engr. of Maintenance, South Side Elev. R. R., 47 Congress St., Chicago, Ill.	Nov. 6, 1907
Clement, Frank Hudson. Engr. and Contr., Land Title Bldg., Philadelphia, Pa. (Res., 124 West 48th St., New York City)	Nov. 1, 1882
Clermont, John Baptiste. Engr. of Bldg. Constr. with V. J. Hedden & Sons Co., 1 Madison Ave., New York City. (*Assoc. M., May 4, 1904*).	Oct. 6, 1908
Coane, John Montgomery. Civ., Hydr., and Min. Engr., 70 Queen St., Melbourne, Victoria, Australia	Nov. 4, 1908
Cochrane, Victor Hugo. (Hedrick & Cochrane, Cons. Engrs.), 1118 McGee St., Kansas City, Mo. (*Assoc. M., Oct. 4, 1905*)	Dec. 6, 1910
Code, William Henry. Chf. Engr., U. S. Indian Service, 522 Bumiller Bldg., Los Angeles, Cal.	June 5, 1907
Codwise, Edward Bertie. 298 Wall St., Kingston, Ulster Co., N. Y.	Sept. 5, 1888
Coe, David. Care, S. Pearson & Son, Sucrs., Apartado 54, Vera Cruz, Mexico	Sept. 7, 1904
Coe, William Watson. Gen. Mgr., Pocahontas Coal & Coke Co., Roanoke, Va.	April 3, 1889
Coffin, Amory. 12 Riggs Pl., South Orange, N. J.	Mar. 3, 1875
Coffin, Thomas Amory. Engr. and Contr., 45 Broadway, New York City. (*Jun., Oct. 2, 1894*)	Feb. 1, 1899
Cogswell, William Brown. Vice-Pres. and Managing Director, The Solvay Process Co., Syracuse, N. Y. (*Assoc., Feb. 15, 1871*)	Oct. 16, 1872
Cohen, Frederick William. Engr. of Erection, Bridge and Constr. Dept., The Pennsylvania Steel Co., Steelton, Pa. (*Assoc. M., Feb. 3, 1897*)	Sept. 3, 1902
COHEN, MENDES. (*Past-President*). 825 N. Charles St., Baltimore, Md.	Dec. 4, 1867
Colby, Albert Ladd. Cons. Engr., and Iron and Steel Metallurgist, 447 Lehigh St., South Bethlehem, Pa.	Oct. 7, 1903
Colby, Branch Harris. Cons. Engr., 812 Security Bldg., St. Louis, Mo.	June 5, 1895
Cole, Daniel Webster. Project Engr., U. S. Reclamation Service, Fallon, Nev.	June 7, 1905
Cole, Harry Outen. Asst. Engr., Pac. Div., Isthmian Canal Comm., Corozal, Canal Zone, Panama. (*Assoc. M., Jan. 4, 1905*)	May 3, 1910
Cole, Howard Judson. Gen. Supt., Caisson Co., Fifth Ave. Bldg., New York City. (*Assoc. M., Jan. 6, 1892*)	Mar. 1, 1899
Cole, John Adams. Cons. Engr., 310 Ashland Blk., Chicago, Ill.	Mar. 7, 1894
Cole, William Weeden. Mgr. of Utilities Dept., Dodge & Day, 608 Chestnut St., Philadelphia, Pa.	Oct. 7, 1903
Coleman, Clarence. U. S. Asst. Engr., Engr. Office, U. S. A., Duluth, Minn.	Nov. 3, 1897
Coleman, Frederick Albert. Pres., The J. D. Smith Foundry Supply Co., 1846 Scranton Rd., Cleveland, Ohio. (*Jun., April 4, 1893; Assoc. M., April 5, 1899*)	Dec. 1, 1903
Coleman, John Francis. (J. F. Coleman & Co.), 920 Hibernia Bldg., New Orleans, La.	Oct. 2, 1901
Collier, Bryan Cheves. With H. S. Kerbaugh, Valhalla, N. Y. (Res., 2721 Bainbridge Ave., Bronx, New York City.) (*Assoc. M., Oct. 3, 1900*)	June 4, 1907
Collingwood, Francis. 211 South Broad St., Elizabeth, N. J.	Mar. 3, 1869
Collins, Daniel Charles Newman. Cons. Engr., 29 Broadway, New York City.	April 3, 1901
Collins, Roderick Greene, Jr. Chf. Engr., New York Contr. Co., 1 Madison Ave., Room 5200, New York City	May 4, 1904
Colpitts, Walter William. Chf. Engr., K. C., M. & O. Ry. Co., 406 U. S. & Mex. Trust Bldg., Kansas City, Mo.	Nov. 1, 1905
Compton, Charles Sumner. Cons. Engr., Northern Elec. Ry. Co., and E. B. & A. L. Stone Co., Orloff, Butte Co., Cal.	June 3, 1908
Comstock, Charles Worthington. State Engr., Boston Bldg., Denver, Colo. (*Jun., April 5, 1892; Assoc. M., Feb. 7, 1900*)	Sept. 5, 1905
Conard, Clarence Knight. Asst. Engr., Erie R. R. Co., 50 Church St., Room 977, New York City	Oct. 5, 1909
Condron, Theodore Lincoln. Cons. Bridge and Structural Engr., 1214 Monadnock Bldg., Chicago, Ill. (*Assoc. M., Feb. 1, 1899*)	Oct. 2, 1901

	Date of Membership
Conkling, Cloud Clifford. Cons. Civ. Engr., 798 Ellicott Sq. Bldg., Buffalo, N. Y.	Jan. 4, 1905
Conn, Frank Winslow. Care, Hammond Mfg. Co., 54 First St., Portland, Ore.	June 1, 1904
Connett, Albert Neumann. Chf. Engr., J. G. White & Co., Ltd., 9 Cloak Lane, London, E. C., England. *(Jun., June 6, 1883)*	Oct. 1, 1890
Connick, Harris De Haven. Chf. Asst. Engr., Board of Public Works, David Hewes Bldg., San Francisco, Cal. *(Jun., Jan. 3, 1899; Assoc. M., Feb. 4, 1903)*	Feb. 1, 1910
Connor, Edward Hanson. Vice-Pres., Mo. Val. Bridge & Iron Co., Leavenworth, Kans. *(Jun., Feb. 5, 1890; Assoc. M., Feb. 3, 1892)*	April 4, 1900
Connor, Samuel Powers. 230 West 107th St., New York City. *(Assoc. M., Nov. 7, 1906)*	Jan. 7, 1908
Connor, William Durward. Maj., Corps of Engrs., U. S. A., Commanding First Battalion of Engrs., and Director of Civ. Eng., U. S. Engr. School, Washington Barracks, Washington, D. C. *(Assoc. M., Jan. 7, 1903)*	May 31, 1910
Conover, Charles E. Designing Engr., Public Service Comm., 23 Flatbush Ave., Brooklyn, N. Y.	Nov. 1, 1910
Constable, Howard. Archt., Lyons Falls, Lewis Co., N. Y.	Dec. 7, 1892
Constant, Frank Henry. Prof. of Structural Eng., Univ. of Minnesota, Minneapolis, Minn. *(Assoc. M., Dec. 2, 1896)*	April 2, 1907
Contri, Silvio. Archt., 1a General Prim No. 15, City of Mexico, Mexico.	July 1, 1908
Conway, George Robert Graham. Hydr. and San. Engr., 514 Paulsen Bldg., Spokane, Wash.	Dec. 4, 1907
Cook, Frederick Scott. Div. Engr., Croton Falls Reservoir, The Aqueduct Commrs., 280 Broadway, New York City (Res., Yonkers, N. Y.).	June 3, 1908
Cook, John Henry. Hydr. Engr., Society for Establishing Useful Manufactures, 158 Ellison St., Paterson, N. J. *(Assoc. M., May 4, 1898)*	Jan. 4, 1910
Cooley, Lyman Edgar. 21 Quincy St., Chicago (Res., Evanston), Ill.	June 1, 1898
Cooley, Maurice Wurtz. Gen. Mgr., Uintah Ry., Mack, Colo. *(Assoc. M., Mar. 7, 1894)*	Dec. 3, 1902
Coombs, Philip Henry. Civ. Engr. and Surv., 37 Exchange Blk., 25 State St., Bangor, Me.	Mar. 7, 1906
Coombs, Robert Duncan. Engr. and Contr. (Fitzpatrick & Coombs), 1123 Broadway, New York City. *(Jun., May 2, 1899; Assoc. M., Feb. 7, 1900)*	Jan. 7, 1908
Coombs, Stephen Elbridge. 335 Madison Ave., Room 1101, New York City	Sept. 3, 1902
Cooper, Hugh Lincoln. Cons. Engr. (Cooper & Powelson), 60 Wall St., New York City	Sept. 6, 1905
Cooper, Samuel Lispenard. City Engr., Yonkers, N. Y.	Feb. 6, 1889
N. N. Cooper, Theodore. 45 Broadway, New York City	Mar. 4, 1874
Cornell, George Birdsall. 67 Montclair Ave., Montclair, N. J. *(Jun., Aug. 6, 1879)*	Oct. 6, 1886
Cornell, John Nelson Hayward. 29 Broadway, New York City. *(Jun., May 1, 1889)*	June 1, 1909
Corner, Charles. Res. Engr., Rhodesia Rys. (Northern Extensions), Box 422, Bulawayo, Rhodesia, South Africa. *(Assoc. M., May 1, 1895)*	Mar. 5, 1907
Cornish, Lorenzo Dana. Designing Engr., Isthmian Canal Comm., Culebra, Canal Zone, Panama. *(Jun., April 5, 1904; Assoc. M., Feb. 7, 1906)*	June 30, 1910
Coroalles, Manuel Alberto. Chf. Engr., Dept. of Public Works, Cerro 440 B, Havana, Cuba	Aug. 31, 1909
Corry, Thomas Avery. Res. Engr., Ferrocarriles del Sur del Peru, Arequipa, Peru	May 6, 1903
Corthell, Arthur Bateman. Secy. and Cons. Engr., Auxiliary Facilities Committee, 1040 Grand Central Terminal, New York City	Mar. 1, 1899
Corthell, Elmer Lawrence. 149 Broadway, New York City	Sept. 2, 1874
Cory, Harry Thomas. Gen. Mgr., The California Development Co., Calexico, Cal. *(Jun., June 20, 1893; Assoc. M., Mar. 7, 1900)*	Feb. 5, 1907
Cosby, Spencer. Col., Corps of Engrs., U. S. A., 1729 New York Ave., Washington, D. C.	Oct. 5, 1904
Cotton, Joseph P. Newport, R. I.	June 7, 1876
Couchot, Maurice Charles. Room 613, Mechanics Inst. Bldg., San Francisco, Cal. *(Assoc. M., Nov. 1, 1905)*	June 2, 1908
COURTENAY, WILLIAM HOWARD. *(Director)*. Chf. Engr., L. & N. R. R. Co., Louisville, Ky.	July 3, 1889
Coutlee, Charles Robert Foran. Upper Ottawa Storage, Box 560, Ottawa, Ont., Canada	Mar. 1, 1905
Cowan, Herbert Wheeler. Chf. Engr., The Colorado & Southern Ry. Co., 801 Cooper Bldg., Denver, Colo.	June 3, 1908
Cowles, Walter Linsley. Div. Engr., Div. of Design, Chicago Passenger Subways, 181 La Salle St., Chicago, Ill.	Mar. 6, 1889

	Date of Membership
Cowles, William Pierce. Cons. Engr., 614 Flour Exchange, Minneapolis, Minn. (*Assoc. M., Nov. 7, 1906*)	May 3, 1910
Cox, Leonard Martin. Civ. Engr., U. S. N.; Asst. to the Bureau of Yards and Docks, Washington, D. C. (*Assoc. M., Oct. 4, 1899*)	Jan. 5, 1904
Crandall, Charles Lee. Prof. of Ry. Eng., Cornell Univ., Ithaca, N. Y. (*Jun., June 7, 1876*)	Oct. 5, 1892
Crandall, Charles Leo. Vice-Pres., Bowers Southern Dredging Co.; Secy. and Gen. Mgr., Furst-Clark Constr. Co., Sandwich, Mass.	May 4, 1909
Crane, Albert Sears. Chf. Hydr. Engr., J. G. White & Co., 49 Exchange Pl., New York City. (*Jun., Sept. 3, 1895; Assoc. M., May 4, 1898*)	May 1, 1901
Crane, Clarence Austin. Cons. Engr., 21 Park Row, New York City. (*Assoc. M., Mar. 5, 1902*)	May 4, 1909
Crane, Francis Elihu. City Engr., Amsterdam, N. Y.	Oct. 1, 1902
Craven, Alfred. Engr. of Subway Constr., Public Service Comm., First Dist., 154 Nassau St., New York City	Dec. 5, 1888
Crawford, Joseph Emmanuel. Bridge Engr., Norfolk & West. Ry. Roanoke, Va. (*Jun., Dec. 5, 1899*)	June 3, 1908
Crawford, William. Address unknown	Nov. 7, 1888
Crecelius, Samuel Forder. 403 Equitable Bldg., Louisville, Ky.	Dec. 4, 1907
Crehore, William Williams. Cons. Engr., 30 Church St., New York City. (*Assoc. M., April 4, 1894*)	Sept. 3, 1902
Crellin, Edward Webster. Pres., Des Moines Bridge & Iron Works, Park Bldg., Pittsburg, Pa.	Mar. 2, 1909
Cresson, Benjamin Franklin, Jr. Deputy Commr., Dept. of Docks and Ferries, Pier A, North River (Res., 32 West 40th St.), New York City. (*Assoc. M., April 2, 1902*)	Jan. 7, 1908
Creuzbaur, Robert Walter. Cons. Engr. of Public Works, Borough Hall, Brooklyn, N. Y. (*Jun., April 2, 1890; Assoc. M., April 4, 1894*)	April 4, 1900
Crew, Charles Corwin. Gen. Mgr., A. Wyckoff & Son Co. of La., Alexandria, La. (*Assoc. M., April 1, 1903*)	June 1, 1909
Crider, James Leland. Chf. Engr., N. Y., Westchester & Boston Ry. Co.; Chf. Engr., Westchester Northern R. R. Co., 65 Beaver St., New York City.	Jan. 3, 1906
Crockard, Frank Hearne. Vice-Pres. and Gen. Mgr., Tennessee Coal, Iron & R. R. Co., Birmingham, Ala.	Oct. 4, 1910
Crocker, Herbert Samuel. Cons. Engr., 811 Seventeenth St., Suite 438, Denver, Colo.	Oct. 2, 1901
Crosby, Benjamin Lincoln. Div. Engr., N. P. Ry. Co., Tacoma, Wash. (*Jun., June 2, 1880*)	Oct. 6, 1886
Crosby, Horace. 38 Trinity Pl., New Rochelle, N. Y.	Feb. 17, 1869
Crosby, Walter Wilson. Chf. Engr., Md. Geologic and Economic Survey; Chf. Engr., Md. Roads Comm., Baltimore, Md.	July 10, 1907
Croswell, Thomas Henry. E. 8 Hill Ave., Spokane, Wash.	Oct. 7, 1908
Crowell, Foster. Cons. Civ. Engr., 18 Broadway, New York City.	Dec. 1, 1880
Crozier, William. Brig.-Gen., Chf. of Ordnance, U. S. A., War Dept., Washington, D. C.	Feb. 1, 1905
Crump, Ralph Lee. Care, Ford, Bacon & Davis, 921 Canal St., New Orleans, La.	Dec. 3, 1902
Cuddeback, Allan Winter. Engr. and Supt., Passaic Water Co., Paterson, N. J. (*Assoc. M., April 5, 1899*)	Mar. 1, 1910
Cullen, James Francis. Asst. Engr. of Constr., P. R. R., 510 South 48th St., Philadelphia, Pa.	May 2, 1906
Cummings, Robert Augustus. Civ. and Cons. Engr., Pittsburg, Pa. (*Jun., Oct. 1, 1890; Assoc. M., May 4, 1892*)	June 1, 1898
Cummings, William Warren. 15 Winter St., Woburn, Mass.	June 7, 1899
Cunningham, Andrew Chase. Civ. Engr., U. S. N.; Insp. of Public Works, Navy Dept., Washington, D. C. (*Assoc. M., Sept. 2, 1891*)	Oct. 3, 1894
Cunningham, Andrew Oswald. Chf. Engr., Wabash R. R. Co., Lincoln Trust Bldg., St. Louis, Mo.	Feb. 5, 1902
Cunningham, David West. 627 West 18th St., Los Angeles, Cal.	May 7, 1873
Cunningham, James Henry. 2 Ravelston Pl., Edinburgh, Scotland.	Aug. 6, 1879
Cunningham, Joseph Hooker. Cons. Hydr. Engr., Sherlock Bldg., Portland, Ore. (*Assoc. M., Sept. 6, 1899*)	Feb. 2, 1904
Curtis, Charles Elbert. Civ. Engr., Cambria Steel Co., Capital Hotel, Johnstown, Pa.	Oct. 4, 1905
Curtis, Fayette Samuel. Pres., Old Colony R. R., Boston, Mass.	April 3, 1889
Curtis, Loren Bradley. 710 Kittredge Bldg., Denver, Colo. (*Assoc. M., July 10, 1907*)	Nov. 1, 1910
Curtis, Walter Whaley. Cons. Engr., 355 Dearborn St., Chicago, Ill.	Sept. 5, 1888
Cushing, Edward Benjamin. 210½ Main St., Houston, Tex.	Nov. 1, 1893
Cushing, William Channing. Chf. Engr., M. of W., South-West System, Penn. Lines, Union Station, Pittsburg, Pa. (*Jun., June 5, 1889; Assoc. M., Nov. 4, 1891*)	May 1, 1901
Cushman, William Herbert. 235 Cayuga St., Fulton, N. Y.	Jan. 3, 1906

	Date of Membership
Dabney, Augustine Lee. Asst. Chf. Engr., Tallahatchie Drainage Comm., Clarksdale, Miss	Oct. 2, 1901
Dabney, Thomas Gregory. Chf. Engr., Yazoo-Mississippi Delta Levee Dist., Clarksdale, Miss	Jan. 3, 1906
Daggett, Herbert Chapin. New England Mgr. and Engr., S. Morgan Smith Co., 176 Federal St., Boston, Mass	July 10, 1907
Dahm, Sverre. Gen. Insp. of Designs, Public Service Comm. for the First Dist., 154 Nassau St., New York City	Feb. 7, 1906
Dakin, Albert Harlow, Jr. 370 St. Nicholas Ave., New York City	April 1, 1903
Dallis, Park Andrew. Mill Archt. and Engr., 1023 Candler Bldg., Atlanta, Ga. (*Assoc. M., June 1, 1904*)	Jan. 4, 1910
Dalton, B. J. Assoc. Prof., Railway Eng., Univ. of Kansas, 1011 Indiana St., Lawrence, Kans	Oct. 2, 1907
Dana, Richard Turner. Civ. and Cons. Engr., 15 William St., New York City. (*Jun., Sept. 11, 1900; Assoc. M., Feb. 4, 1903*)	Jan. 7, 1908
Danforth, Frederic. 29 Pleasant St., Gardiner, Me	Sept. 2, 1891
Danforth, Richard Eugene. 7 Central Ave., Newark, N. J	Oct. 3, 1906
Darling, Fred Steere. Joyces Chambers, Phillips Sq., Montreal, Que., Canada.	Oct. 7, 1903
Darling, John Henry. U. S. Prin. Asst. Engr., 532 West Third St., Duluth, Minn	May 1, 1901
Darling, William Lafayette. Chf. Engr., N. P. Ry. Co., St. Paul, Minn.	Oct. 5, 1892
Darnell, James Lee. Cons. Engr., 516 Midland Bldg., Kansas City, Mo.	Oct. 4, 1910
Darrach, Charles Gobrecht. Pres. and Chf. Engr., Mt. Vernon Impvt. Co., Mt. Vernon, Skagit Co., Wash	Jan. 5, 1876
Darrow, Frank Tenney. Engr., M. of W., C., B. & Q. R. R. Lines West of Missouri River, Lincoln, Nebr. (*Assoc. M., May 1, 1907*)	May 4, 1909
Dart, Carlton Rollin. Bridge Engr., San Dist. of Chicago, 1500 Am. Trust Bldg., Chicago, Ill	May 6, 1903
Dart, Justus Vinton. Asst. Engr. in Chg. of Highway Dept., City Hall, Providence, R. I	April 4, 1900
Datesman, George Elvin. Prin. Asst. Engr., Bureau of Surveys, 416 City Hall, Philadelphia, Pa	Feb. 4, 1903
Dauchy, Walter Edward. 1526 West 8th St., Riverside, Cal	Nov. 4, 1903
Davenport, James Aubrey. Engr. in Chg., Double Track, Welch, W. Va. (Res., 402 Fourteenth Ave., S. W., Roanoke, Va.)	April 5, 1905
Davidson, Frank Eugene. Archt. and Cons. Engr. (Patterson & Davidson), 1448 Monadnock Blk. (Res., 7436 Kimbark Ave.), Chicago, Ill.	Nov. 4, 1908
Davies, John Vipond. (Jacobs & Davies, Cons. Engrs.), 30 Church St., New York City	June 6, 1894
Davis, Arthur Lincoln. Asst. to Pres., Am. Bridge Co. of N. Y., 30 Church St., New York City. (*Jun., April 4, 1893; Assoc. M., Oct. 7, 1896*)	Mar. 6, 1906
Davis, Arthur Powell. Chf. Engr., U. S. Reclamation Service, Washington, D. C. (*Assoc. M., June 7, 1393*)	Oct. 4, 1899
Davis, Carleton Emerson. Dept. Engr., Board of Water Supply, City of New York, Brown Station, N. Y. (*Assoc. M., April 6, 1898*)	Mar. 3, 1908
Davis, Chandler. 11 Broadway, New York City. (*Jun., Dec. 3, 1890; Assoc. M., Feb. 6, 1895*)	Oct. 4, 1899
Davis, Charles E. L. B. Brig.-Gen., U. S. A. (*Retired*), The Benedick, Washington, D. C	July 12, 1877
Davis, Charles Henry. South Yarmouth, Mass	Dec. 4, 1895
Davis, Charles Stratton. Cons. Engr., 34 West 44th St., New York City	Feb. 1, 1905
Davis, Chester Birge. 3353 Sixth Ave., Troy, N. Y	Feb. 1, 1882
Davis, John Rose Wilson. Engr., M. of W., G. N. Ry. Line, St. Paul, Minn.	Nov. 4, 1903
Davis, Joseph Baker. Prof., Geodesy and Surveying, Univ. of Michigan, Ann Arbor, Mich. (*Jun., April 1, 1874*)	Oct. 5, 1898
Davis, Joseph Phineas. 332 Palisade Ave., Yonkers, N. Y	Jan. 29, 1868
Davis, Leonard Henry. Mgr. and Chf. Engr., The Michigan Lake Superior Power Co.; Chf. Engr., The Lake Superior Power Co., Sault Ste. Marie, Ont., Canada. (*Assoc. M., Nov. 5, 1902*)	May 4, 1909
Davis, Lynn LeRoy. U. S. Asst. Engr., 540 Federal Bldg., Buffalo, N. Y.	Nov. 30, 1909
Davis, Noah Wilson. Harrisonburg, Va	July 9, 1906
Davis, Robert Benjamin. Designing Engr., Bost. Elev. Ry. Co., 101 Milk St., Boston, Mass	July 3, 1889
Davison, George Stewart. Cons. Engr., 2512 Oliver Bldg., Pittsburg, Pa	April 2, 1890
Dawley, William Sanborn. Chf. Engr., Yunnan-Szechuan & Tengyueh Ry. Co., Yunnanfu, Yunnan Prov., China	Oct. 4, 1905
Dawson, Edwin Ford. Asst. to Chf. Engr., P. & R. Ry., Room 516, Reading Terminal, Philadelphia, Pa	Mar. 4, 1908
Dean, Arthur Warren. Chf. Engr., Mass. Highway Comm., 15 Ashburton Pl., Boston, Mass	May 4, 1904
Dean, Bertram Dodd. Chf. Engr., Puget Sound Bridge & Dredging Co., 2322 Thirty-second Ave., South, Seattle, Wash	Aug. 31, 1909

	Date of Membership
Dean, Luther. Taunton, Mass	May 4, 1898
Deans, John Sterling. Chf. Engr., The Phœnix Bridge Co., Phœnixville, Pa	May 4, 1887
Decrow, David Augustus. Chf. Engr. and Secy., Snow Steam Pump Works, Buffalo, N. Y.	Oct. 4, 1910
Deen, James Work. Div. Engr., D. & R. G. R. R., Salida, Colo	Jan. 6, 1892
Defrees, Morris M. Indianapolis, Ind	Mar. 3, 1880
Degen, Otto William. Supt. of Constr., Quartermaster's Dept., U. S. A., 1718 St. Charles St., Alameda, Cal	April 5, 1910
de la Barre, William. Engr., Agt. and Treas., St. Anthony Falls Water Power Co., Minneapolis, Minn	April 5, 1893
Delano, Frederic Adrian. Pres., Wabash R. R. and Wheeling & Lake Erie R. R., Chicago, Ill	June 4, 1902
Delano, Harry Clark. Chf. of Div. of Port Works, Bureau of Nav., Manila, Philippine Islands	Jan. 3, 1911
Dencer, Frederick William. Engr., Lassig Plant, Am. Bridge Co., Wrightwood and Clybourn Aves., Chicago, Ill. *(Assoc. M., Feb. 7, 1906)*	Nov. 8, 1909
Denise, Charles Meirs. Contr. Engr., Chicago Office, McClintic-Marshall Constr. Co., 1214 First National Bank Bldg., Chicago, Ill	May 3, 1910
Dennis, Arthur Crisfield. Vice-Pres. and Gen. Mgr., Watanga Development Co., Emery, Utah	Dec. 4, 1901
R. Dennis, William Franklin. 1407 Sixteenth St., Washington, D. C	Feb. 1, 1888
Derby, George McClellan. Lt.-Col., U. S. A. *(Retired)*, 1015 Carrollton Ave., New Orleans, La	April 1, 1896
Derleth, Charles, Jr. Prof., Civ. Eng., Civil Eng. Bldg., Univ. of California, Berkeley, Cal. *(Jun. Feb. 1, 1898; Assoc. M., Mar. 5, 1902)*.	May 5, 1908
Derrick, Guy Hamilton. Box 592, Pulaski, Va	May 3, 1910
Derrick, Henry Clay. Houston, Halifax Co., Va	Oct. 5, 1887
de Varona, Ignacio Marea. Chf. Engr., Dept. of Water Supply, Gas and Electricity, 13 Park Row Bldg., New York City	April 7, 1886
Develin, Richard Griffith. Asst. Engr., M. W., Bridges and Bldgs., P. R. R. Co., Broad St. Station, Philadelphia, Pa	May 1, 1907
Devin, George. 45 Broadway, New York City	Sept. 7, 1887
De Witt, Philip Hoffecker. Contr. and Engr., S. B. Mutchler & Co., Phillipsburg, N. J	May 5, 1897
Deyo, Solomon LeFevre. Chf. Engr., Interborough Met. Co., 2108 Fifth Ave., New York City	June 6, 1888
De Young, Isaac. U. S. Asst. Engr., Sault Ste. Marie, Mich. *(Assoc. M., Dec. 5, 1906)*	Jan. 4, 1910
Didier, Paul. Prin. Asst. Engr., B. & O. R. R. Co., North Side, Pittsburg, Pa	Mar. 6, 1889
Diebitsch, Emil. Vice-Pres., John Peirce Co., 90 West St., New York City (Res., 38 Burnett Pl., Nutley, N. J.). *(Jun., Feb. 28, 1893; Assoc. M., Oct. 6, 1897)*	Mar. 5, 1902
Diehl, George Conrad. County Engr., 575 Ellicott Sq., Buffalo, N. Y.	May 31, 1910
Diehr, Alvah Benjamin. U. S. Junior Engr., Box 1017, Memphis, Tenn. *(Assoc. M., Nov. 5, 1902)*	July 1, 1909
Dillenbeck, Clark. Civ. Engr. and Archt.; Asst. Engr., P. & R. Ry. Co., 502 Reading Terminal, Philadelphia, Pa	June 1, 1904
Dillman, George Lincoln. Nevada National Bank Bldg., San Francisco, Cal.	Mar. 4, 1891
Dimock, Arthur Herbert. Asst. City Engr., City Hall, Seattle, Wash.	May 31, 1910
Dimon, Daniel Young. With Eastern Steel Co., 71 Broadway, New York City (Res., 315 Paulison Ave., Passaic, N. J.). *(Assoc. M., Oct. 2, 1901)*	Mar. 31, 1908
Dixon, Charles Young. U. S. Asst. Engr., River and Harbor Impvts., Amherstburg, Ont., Canada	Nov. 4, 1903
Doane, Walter A. Meadville, Pa	Sept. 7, 1881
Doble, William Ashton. Fremont and Howard Sts., San Francisco, Cal.	April 5, 1905
Dobson, Adna. City Engr., Lincoln, Nebr	May 6, 1908
Dockweiler, John Henry. Cons. Engr., 417 Grant Bldg., San Francisco, Cal	May 2, 1906
Dodge, James Lynn. With Westinghouse, Church, Kerr & Co., 10 Bridge St., New York City	July 1, 1908
Doerfling, Richard George. Civ. and Cons. Engr., Monadnock Bldg., San Francisco, Cal. *(Assoc. M., June 3, 1903)*	Mar. 5, 1907
Domenech, Manuel Victor. P. O. Box 613, Ponce, Porto Rico	July 9, 1906
Donham, Benjamin Curtis. With J. G. White & Co., Inc., Constr. Dept., 43 Exchange Pl., New York City (Res., 24 N. 16th St., East Orange, N. J.). *(Assoc. M., Jan. 2, 1901)*	Mar. 31, 1908
Donovan, Cornelius. Prin. Asst. Engr., U. S. Engr. Office, Custom House, New Orleans, La	Oct. 4, 1899
Donovan, John Joseph. Pres., Lake Whatcom Logging Co.; Vice-Pres., Wash. Good Roads Assoc.; Vice-Pres., First National Bank, Bellingham, Wash. *(Jun., April 7, 1886)*	April 4, 1888

	Date of Membership
Doremus, Abraham Fairbanks. Cons. Engr., Salt Lake City, Utah	Oct. 4, 1893
Dorr, Edgar Sutton. Chf. Engr., Sewer Div., Street Dept., 30 Tremont St., Boston, Mass	April 3, 1895
Dose, Henry Frederick. Chf. Engr., Madeira-Mamoré Ry., Caixa No. 304., Manãos, Brazil	Jan. 6, 1904
dos Santos, José Americo. Cons. Civ. Engr., Caixa 748, Rio de Janeiro, Brazil	Oct. 7, 1908
Dougan, William Thomas. Engr., M. of W., Met. St. Ry. Co., 775 Seventh Ave., New York City	Oct. 2, 1907
Douglas, Benjamin. Cons. and Contr. Engr., 814 Ford Bldg., Detroit, Mich. *(Jun., June 1, 1887)*	Jan. 2, 1890
Douglas, Edward Morehouse. Geographer, U. S. Geological Survey, Washington, D. C	Dec. 4, 1901
Douglas, Walter Jules. Care, William Barclay Parsons, Cons. Engr., 60 Wall St., New York City	April 3, 1907
Dow, Alex. Vice-Pres. and Gen. Mgr., The Edison Illuminating Co., 18 Washington Ave., Detroit, Mich	Dec. 5, 1906
Downey, Archibald Stewart. Cons. and Const. Engr., 404 Bailey Bldg., Seattle, Wash	Nov. 30, 1909
Doyle, John Stephen. Cons. Engr., 2451 Maryland Ave., Baltimore, Md. *(Assoc. M., Nov. 7, 1906)*	May 3, 1910
Drake, Albert Bailey. 164 William St., New Bedford, Mass	Oct. 4, 1893
Drake, William Abial. Vice-Pres. and Gen. Mgr., S. F., P. & P. Ry. Co. and Leased Lines, Prescott, Ariz	Dec. 5, 1883
Drury, Edmund Hazen. Sherbrooke, Que., Canada	Oct. 4, 1905
Du Bois, Augustus Jay. Prof. of Civ. Eng., Sheffield Scientific School, New Haven, Conn. *(Jun., July 7, 1875)*	Oct. 5, 1892
Duffies, Edward John. U. S. Asst. Engr. and Supt., Harbor of Refuge, Harbor Beach, Mich	Jan. 3, 1906
Duggan, George Herrick. Second Vice-Pres. and Chf. Engr., Dominion Bridge Co., Ltd., Montreal, Que., Canada	Oct. 2, 1895
Duis, Frederick Bernhardt. U. S. Asst. Engr., 309 South Front St., Wheeling, W. Va. *(Assoc. M., Dec. 5, 1906)*	Jan. 3, 1911
Duncan, Lindsay. Mech. Engr., Steptoe Val. Smelting & Min. Co., McGill, Nev. *(Assoc. M., Feb. 3, 1904)*	Nov. 2, 1908
Duncklee, John Butler. Cons. Engr., 35 Fairview Ave., South Orange, N. J	April 2, 1873
Dunham, Herbert Franklin. 220 Broadway, New York City	Oct. 1, 1890
Dunham, Lewis Augustus. 42 Broadway, New York City	June 3, 1903
Dunham, William Robert, Jr. Asst. Engr., The Connecticut Co., 21 Ford Bldg., New Haven, Conn	July 9, 1906
Dunlap, De Clermont. Pres., Dunlap Eng. Operating Co., Marquette Bldg., Chicago, Ill	Jan. 4, 1888
Dunlap, Frederic Clark. Chf. Engr., Bureau of Water, 790 City Hall, Philadelphia, Pa	June 1, 1904
Dunn, Daniel Burke. Chf. Engr., Georgia, Southwestern & Gulf R. R., Albany, Ga	Dec. 2, 1891
Durham, Henry Welles. Res. Engr., Cape Cod Constr. Co., Sandwich, Mass	Oct. 5, 1909
Duryea, Edwin, Jr. (Duryea, Haehl & Gilman, Civ. and Min. Engrs.), 1314 Humboldt Bank Bldg., San Francisco, Cal. *(Jun., Feb. 2, 1887; Assoc. M., Sept. 4, 1895)*	Feb. 2, 1898
Dyer, Arthur James. Pres. and Chf. Engr., Nashville Bridge Co., Nashville, Tenn. *(Assoc. M., Mar. 6, 1901)*	Feb. 4, 1903
Earl, George Goodell. Room 502, City Hall Annex, New Orleans, La. *(Jun., May 7, 1890; Assoc. M., Dec. 2, 1891)*	April 4, 1894
Earle, Thomas. Supt., Bridge and Constr. Dept., Pennsylvania Steel Co., Steelton, Pa	Mar. 6, 1907
Easby, Marmaduke Ward. Cons. and Const. Engr., 1420 Chestnut St., Philadelphia, Pa. *(Assoc. M., Nov. 4, 1891)*	Dec. 1, 1897
Easby, William, Jr. Prof. of Municipal Eng., Univ. of Pennsylvania, Philadelphia, Pa	Jan. 4, 1905
Easterbrook, Frederick James. 82 York Sq., New Haven, Conn	May 3, 1905
Eastwood, John Thompson. Prin. Asst. Engr., Sewerage and Water, Sewerage and Water Board, New Orleans, La. *(Jun., Mar. 6, 1894; Assoc. M., Feb. 1, 1899)*	Sept. 6, 1904
Eaton, Frederick. 838 Fourth St., Santa Monica, Cal	May 5, 1886
Eavenson, Howard Nicholas. Chf. Engr., United States Coal & Coke Co., Gary, McDowell Co., W. Va. *(Assoc. M., Mar. 6, 1901)*	May 1, 1906
Eber, John William. Supt., N. Y. C. & H. R. R. R. Co., Utica, N. Y. *(Assoc. M., Sept. 4, 1907)*	Sept. 6, 1910
Eckart, Nelson Andrew. Res. Engr., Snow Mountain Water & Power Co., 3014 Clay St., San Francisco, Cal. *(Assoc. M., Nov. 1, 1905)*	Jan. 3, 1911

	Date of Membership
Eckart, William Roberts. Cons. Engr., 3014 Clay St., San Francisco, Cal.	Jan. 5, 1881
Eckersley, Joseph Oscar. 4269 White Plains Ave., New York City.	Aug. 31, 1909
Eddy, Albert Clark. Asst. Engr., Great Northern Ry. Co., 320 Second St., New Westminster, B. C., Canada.	Dec. 6, 1910
Eddy, Harrison Prescott. (Metcalf & Eddy, Cons. Engrs.), 14 Beacon St., Boston Mass. *(Assoc. M., May 7, 1902)*	Jan. 3, 1907
Edes, William Cushing. Chf. Engr., Northwestern Pacific R. R., San Francisco, Cal. *(Jun., Sept. 1, 1886)*	Nov. 4, 1896
Edwards, Harry Winter. Civ. and Cons. Engr., 15 Wall St., New York City.	June 4, 1890
Edwards, James Harvey. Asst. Chf. Engr., Am. Bridge Co., N. Y., 103 Lafayette Ave., Passaic, N. J. *(Jun., May 31, 1892; Assoc. M., May 2, 1894)*	May 4, 1898
Edwards, Warrick Rigeley. Asst. Engr. of Bridges, B. & O. R. R., Baltimore, Md. *(Assoc. M., April 4, 1900)*	Sept. 6, 1910
Ehle, Boyd. 34 East Radford St., Yonkers, N. Y. *(Assoc. M., Jan. 3, 1894)*	Feb. 1, 1910
Eidlitz, Otto Marc. Engr. and Builder, 489 Ffith Ave., New York City.	Sept. 2, 1902
Eldridge, Chauncey. 53 State St., Boston, Mass.	May 2, 1906
Eldridge, Griffith Morgan. Mgr., Eldridge Drug Stores, Americus, Ga. *(Assoc. M., June 1, 1892)*	Sept. 3, 1902
Ellery, Nathaniel. State Engr., Sacramento, Cal.	Nov. 8, 1909
Elliott, Charles Gleason. Chf. of Drainage Investigations, U. S. Dept. of Agriculture, Washington, D. C.	Sept. 3, 1890
Elliott, James Rutherford. Cons. Engr., Arlington Sta., Riverside, Cal. *(Assoc. M., Sept. 4, 1901)*	April 5, 1904
Elliott, James William. 17 Adsit Pl., Burlington, Vt. *(Assoc. M., April 6, 1909)*	June 30, 1910
Ellis, George Ezra. Signal Engr., Kansas City Terminal Ry. Co., 23d St. and Grand Ave., Kansas City, Mo. *(Jun., Mar. 2, 1897; Assoc. M., Mar. 7, 1900)*	Dec. 4, 1901
Ellis, John Waldo. Cons. Engr., Woonsocket, R. I.	July 3, 1895
Ellis, Samuel Clarence. P. O. Box 1439, Boston, Mass.	Aug. 7, 1872
Ellsworth, Emory Alexander. Civ. and Hydr. Engr., 18 Dwight St., Holyoke, Mass.	June 1, 1904
Elmer, Howard Nixon. Mgr., Chicago Office, The Trenton Iron Co., 1122 Monadnock Blk., Chicago, Ill.	April 7, 1886
Elwell, Charles Clement. Engr., The Connecticut Co., Cor., State and Chapel Sts., New Haven, Conn.	July 1, 1891
Ely, Theodore Newel. Chf. of Motive Power, P. R. R., Broad St. Station, Philadelphia, Pa.	Mar. 2, 1881
Emerson, Guy Carleton. Cons. Engr., Boston Finance Comm., 410 Tremont Bldg., Boston, Mass.	May 4, 1904
Emery, James Albert. Cons. Engr. with Ford, Bacon & Davis, 115 Broadway, New York City.	June 4, 1902
Emig, John Witmer. Western Representative for E. C. & R. M. Shankland, 1229 Foster Bldg., Denver, Colo.	Oct. 5, 1909
Emmons, Charles Morton. Bridge and Structural Engr., Penn Bridge Co., Beaver Falls, Pa.	April 1, 1903
Endemann, Herman Karl. Asst. Engr. in Chg., Topographical Bureau, Borough of Queens, 252 Jackson Ave., Long Island City, N. Y. *(Assoc. M., Mar. 6, 1901)*	Jan. 5, 1909
ENDICOTT, MORDECAI THOMAS. *(President)*. Civ. Engr., U. S. N.; Rear-Admiral *(Retired)*, 1330 R St., N. W., Washington, D. C.	April 4, 1877
Endo, Tokichi. Engr., M. of W. and Works Section, Imperial Govt. Rys., Tokyo, Japan.	Feb. 1, 1905
Eno, Frank Harvey. Prof. of Municipal Eng., Ohio State Univ., Columbus, Ohio.	Mar. 4, 1903
Ensign, Guert William. Asst. State Highway Commr., Harrisburg (Res., Camp Hill), Pa. *(Assoc. M., Nov. 4, 1908)*	Sept. 6, 1910
Ericson, John Ernst. City Engr. of Chicago, 1934 Kenmore Ave., Chicago, Ill.	May 7, 1902
Erlandsen, Oscar. Pres., Metropolis Eng. Co., 359 Fulton St., Jamaica, N. Y. *(Jun., May 1, 1889; Assoc. M., Dec. 2, 1891)*	Oct. 7, 1896
Ernst, Oswald Herbert. Brig.-Gen., U. S. A. *(Retired)*; Chairman, Am. Section, International Waterways Comm., Westory Bldg., Washington, D. C.	July 4, 1888
Esselstyn, Horace Hovey. Engr., Westinghouse, Church, Kerr & Co., 274 Vinewood Ave., Detroit, Mich.	June 3, 1908
Estep, Josiah Madison. Asst. Chf. Engr., Dept. of Public Service, Cleveland, Ohio.	Mar. 1, 1910
Evans, Edwin George. Hampton, N. B., Canada.	July 10, 1907
Evans, Louis Hyde. Cons. Engr., Exchange Bldg., Union Stock Yards, Chicago, Ill.	July 3, 1889
Evans, Richard. 358 Fulton St., Jamaica, N. Y.	June 7, 1893

	Date of Membership
Evans, Robert Rogers. 24 Arlington St., Haverhill, Mass.	July 1, 1909
Ewen, John Meiggs. Cons. Engr., 740 Rookery Bldg., Chicago, Ill.	June 3, 1903
Ewing, William Bion. Cons. Municipal Engr., 4136 Ellis Ave., Chicago, Ill. *(Jun., April 3, 1889; Assoc. M., Feb. 3, 1892)*	Nov. 2, 1898
Ewing, William Wallace. Engr., Westinghouse, Church, Kerr & Co., 10 Bridge St., New York City (Res. 426 Lenox Ave., Westfield, N. J.)	Oct. 7, 1908
Fairchild, Samuel Edwards, Jr. Civ. and Min. Engr., 306 Franklin Bldg., Philadelphia, Pa. *(Assoc. M., Dec. 7, 1904)*	Oct. 6, 1908
Fairleigh, James Andrew. Secy. and Treas., Cushman-Fairleigh Eng. Co., 724 James Bldg., Chattanooga, Tenn.	Sept. 2, 1891
Falk, Myron Samuel. Cons. Engr., 30 Church St. (Res., 44 West 53d St.), New York City. *(Jun., Feb. 4, 1902; Assoc. M., Oct. 4, 1905)*	April 6, 1909
Fargo, William Gilbert. Civ. and Hydr. Engr., 303 Commonwealth Bldg., Jackson, Mich.	April 1, 1908
Farley, Godfrey Pearson. Cons. Engr., 58 West 59th St., New York City	June 6, 1900
Farley, John Moyer. Cons. Engr., 527 Fifth Ave., New York City. *(Jun., Dec. 5, 1888; Assoc. M., July 1, 1891)*	Sept. 1, 1897
Farley, Philip Patrick. Pres., Jamaica Bay Impvt. Comm., 180 Montague St. (Res., 194 McDonough St.), Brooklyn, N. Y. *(Jun., Oct. 31, 1893; Assoc. M., Mar. 6, 1901)*	Feb. 1, 1910
Farnham, Robert, Jr. Asst. Engr., P. R. R., Broad St. Station, Philadelphia, Pa. *(Assoc. M., July 9, 1906)*	April 5, 1910
Farnum, Henry Harrison. 150 East 150th St., New York City	July 1, 1891
Farnum, Loring Nelson. Vice-Pres., J. G. White & Co., Inc., 43 Exchange Pl., New York City	Dec. 4, 1907
Farrar, Hartwell Prentice. Cons. Engr., Jackson, Tenn.	Nov. 1, 1893
Farrington, Harvey. Cons. and Contr. Engr., 45 Broadway, New York City. *(Jun., June 19, 1891; Assoc. M., Feb. 6, 1895)*	Oct. 1, 1902
Fauntleroy, James Dearing. Care, U. S. Reclamation Service. Yuma, Ariz.	June 5, 1907
Fay, Edward Bayrd. (Brenneke & Fay, Cons. Engrs.), 1200 Fullerton Bldg., St. Louis, Mo. *(Assoc. M., Jan. 8, 1902)*	Jan. 2, 1906
Fay, Frederic Harold, Div. Engr., Bridge and Ferry Div., Public Works Dept., 60 City Hall, Boston, Mass *(Jun., Oct. 2, 1894; Assoc. M., April 2, 1902)*	Jan. 5, 1904
Fehr, Harrison Robert. Pres. and Gen. Mgr., Easton Transit Co., Easton, Pa.	Oct. 5, 1898
Felt, Charles Frederick Wilson. Chf. Engr., A., T. & S. F. Ry., Topeka, Kans.	Mar. 3, 1897
Feltham, Percy Marshall. Greenville, S. C.	July 1, 1908
Felton, Burton Rogers. Treas., C. E. Trumbull Co., Engrs. and Contrs., Tremont Bldg., Boston, Mass. *(Assoc. M., April 4, 1894)*	Oct. 7, 1896
Felton, Herbert Clark. Supt., Del. River Ferry Co. of N. J. of P. & R. Ry. System, Camden, N. J.	June 1, 1887
Felton, Samuel Morse. 1121 Peoples Gas Bldg., Chicago, Ill.	Jan. 4, 1882
Fendall, Benjamin Truman. City Engr., 141 W. Lanvale St., Baltimore, Md.	May 7, 1902
N. **Fenkell, George Harrison.** Civ. Engr. to Water Commrs. (Res., 334 Field Ave.), Detroit, Mich. *(Jun., Jan. 3, 1899; Assoc. M., Oct. 1, 1902)*	July 1, 1909
Fenn, Robert Willson. Mgr., Mfg. Dept., Union Oil Co. of California, Room 229, Mills Bldg., San Francisco, Cal. *(Assoc. M., July 10, 1907)*.	Sept. 1, 1908
Fenn, William Henry. Room 226, du Pont Bldg., Wilmington, Del.	July 1, 1909
Ferguson, George Robert. Asst. Engr., Dept. of Bridges, 1215 Park Row Bldg., New York City	Dec. 3, 1902
Ferguson, Hardy Smith. Chf. Engr., Great Northern Paper Co., Millinocket, Me. *(Assoc. M., Mar. 3, 1897)*	May 1, 1901
Ferguson, James Easton. Operating Engr., The Toledo Bridge & Crane Co., 2115 Park Pl., Toledo, Ohio. *(Assoc. M., June 1, 1904)*	Jan. 3, 1911
Ferguson, John Berton. (J. B. Ferguson & Co., Civ. and Mech. Engrs.), Hagerstown, Md.	July 1, 1909
Ferguson, John Neil. Asst. Engr., Massachusetts Board of Harbor and Land Commrs., Room 131, State House, Boston, Mass. *(Assoc. M., Oct. 2, 1901)*	May 5, 1908
Ferguson, John William. Engr. and Bldg. Contr., 152 Market St., Paterson, N. J. *(Jun., Jan. 5, 1881)*	Feb. 2, 1887
Fernald, Clarence Thayer. First Asst. Engr., Elev. and Subway Constr., Boston Elev. Ry. Co., 32 Malvern St., Melrose, Mass.	Oct. 7, 1908
Fernstrom, Henning. Chf. Engr., The Virginian Ry. Co., Norfolk, Va.	May 7, 1902
Ferry, Charles Addison. With A. B. Hill, Cons. Civ. Engr., 24 Edgewood Ave., New Haven, Conn. *(Jun., May 4, 1881)*	Jan. 2, 1889
Fetherston, John Turney. Supt. of Street Cleaning, Borough of Richmond, New York City (Res., 16 Lenox Pl., New Brighton, N. Y.). *(Assoc. M., June 3, 1903)*	Oct. 5, 1909

	Date of Membership
Fickes, Clark Robinson. Bridge Dept., C., B. & Q. R. R., 209 Adams St., Chicago, Ill	Nov. 7, 1906
Fickes, Edwin Stanton. Chf. Engr. and Purchasing Agt., Aluminum Co. of America, Pittsburg, Pa. (*Jun., Jan. 4, 1898; Assoc. M., Feb. 6, 1901*)	Dec. 6, 1904
Fiebeger, Gustave Joseph. Lt.-Col., Corps of Engrs., U. S. A.; Prof. of Eng., West Point, N. Y.	Oct. 2, 1895
Field, Frederick Elbert. Flood Comm. of Pittsburg, 1804 Arrott Bldg., Pittsburg, Pa. (*Assoc. M., Oct. 7, 1903*)	Sept. 6, 1910
Field, George Russell. Asst. Gen. Mgr., Great Western Power Co., Shreve Bldg., San Francisco, Cal	Nov. 6, 1907
Field, George Spencer. 452 Delaware Ave., Buffalo, N. Y	April 7, 1880
Field, John Ellis. 435 Century Bldg., Denver, Colo	July 1, 1908
Field, William Pierson. 976 Broad St., Newark, N. J. (*Jun., Dec. 7, 1887*)	Mar. 6, 1901
Fields, Samuel James. 632 Ellicott St., Buffalo, N. Y	Mar. 5, 1884
Filley, Oliver Dwight. Superv. Engr., Bureau of Public Works, Philippine Islands, Manila, Philippine Islands	April 5, 1910
Fink, Rudolph. St. Matthews, Ky	Sept. 21, 1870
Finley, Edwin Clifford. Supt., B. and B., Mobile & Ohio R. R., Murphysboro, Ill. (*Assoc. M., April 5, 1905*)	Nov. 30, 1909
Finley, William Henry. Asst. Chf. Engr., C. & N. W. Ry., Batavia, Ill.	Feb. 4, 1903
Firmstone, Frank. Easton, Pa	Aug. 7, 1878
Fish, John Charles Lounsbury. Prof., R. R. Eng., Stanford Univ., Box 233, Stanford University, Cal. (*Jun., Jan. 31, 1893; Assoc. M., Feb. 7, 1900*)	Oct. 6, 1908
Fisher, Edwin Augustus. City Engr., 30 Albemarle St., Rochester, N. Y.	July 4, 1888
Fisher, Francis Davis. Engr. in Chg., Degnon Cape Cod Canal Constr. Co., Sandwich, Mass	May 2, 1888
Fisher, Janon. 613 American Bldg., Baltimore, Md. (*Assoc. M., May 4, 1892*)	Jan. 5, 1898
Fisher, Samuel Brownlee. Chf. Engr., Mo., Kans. & Tex. Ry. Co., 407 Wainwright Bldg., St. Louis, Mo	Oct. 7, 1903
Fisk, Walter Leslie. Col., Corps of Engrs., U. S. A.; Pres., Mississippi River Comm., 1322 Liggett Bldg., St. Louis, Mo	April 1, 1896
Fitch, Asa Betts. 415 W. Prospect Ave., Hollywood Station, Los Angeles, Cal	Mar. 5, 1884
Fitch, Charles Hall. Cons. Engr., 517 North 15th St., Boise, Idaho	June 5, 1901
Fitch, Charles Lincoln. 253 Throop Ave., Brooklyn, N. Y	Oct. 2, 1901
Fitch, Graham Denby. Lt.-Col., Corps of Engrs., U. S. A., U. S. Engr. Office, Duluth, Minn	Feb. 4, 1903
Fitch, Howard Augustus. Pres., Kansas City Structural Steel Co., 1012 Baltimore Ave., Kansas City, Mo	July 9, 1906
N. FITZGERALD, DESMOND. (*Past-President*). Cons. Hydr. Engr., Brookline, Mass	Sept. 3, 1884
Fitzgerald, John Leland. City Engr., 175 Jay St., Schenectady, N. Y.	Jan. 2, 1889
Flad, Edward. Cons. Engr., 1200 Fullerton Bldg., St. Louis, Mo. (*Jun., Jan. 7, 1885*)	Feb. 1, 1888
Flagg, Josiah Foster. 2001 Anacapa St., Santa Barbara, Cal	Oct. 7, 1874
Fleming, Harvey Brown. Chf. Engr., Chicago City Ry. Co., 1640 First National Bank Bldg., Chicago, Ill	Mar. 4, 1908
Fleming, *Sir* Sandford. Ottawa, Ont., Canada	Sept. 18, 1872
Fletcher, Austin Bradstreet. Secy.-Engr., Highway Comm., San Diego County, Room 406, Scripps Bldg., San Diego, Cal	June 1, 1909
Fletcher, Robert. Prof. of Civ. Eng. and Director of Thayer School of Civ. Eng., Dartmouth Coll., Hanover, N. H. (*Assoc., Nov. 4, 1874*)	Aug. 31, 1909
Flinn, Alfred Douglas. Dept. Engr., Board of Water Supply, 165 Broadway, New York City (Res., Glenbrook Ave., Park Hill, Yonkers, N. Y.). (*Assoc. M., Dec. 6, 1899*)	May 2, 1905
Floesch, Jacob Martin. 5643 Northumberland Ave., Pittsburg, Pa	Jan. 4, 1905
Flynn, John, Jr. Civ. and Elec. Engr., 83 Third St., Troy, N. Y. (*Assoc. M., Jan. 8, 1902*)	May 2, 1905
Follett, William W. U. S. Cons. Engr., International Boundary Comm., United States and Mexico, El Paso, Tex	July 5, 1893
Folwell, Amory Prescott. Editor, *Municipal Journal and Engineer*, 239 West 39th St., New York City. (*Jun., Feb. 5, 1890; Assoc. M., June 7, 1893*)	Nov. 3, 1897
FOOTE, ARTHUR DeWINT. (*Director*). Supt., North Star Mines Co., Grass Valley, Cal	May 7, 1884
Force, Cyrus Gildersleeve. Cons. Engr., Flanders, Morris Co., N. J.	Feb. 6, 1878
Ford, Frederick Luther. City Engr., Hartford, Conn. (*Assoc. M., Oct. 1, 1902*)	Oct. 31, 1905
Ford, Porter Dwight. 601 West 168th St., New York City	Jan. 4, 1905
Ford, Theodore Boyden. 946 Main St., Bridgeport, Conn	Dec. 6, 1905
Ford, William Griffing. Cons. Engr., 190 Montague St., Brooklyn, N. Y	Oct. 5, 1904

		Date of Membership
	Ford, William Hayden. Cons. Engr., 1124 Arcade Bldg., Philadelphia, Pa. *(Jun., Nov. 5, 1895; Assoc. M., June 3, 1903)*	Sept. 1, 1908
	Forgie, James. Cons. Engr. (Jacobs & Davies), 30 Church St., New York City	Oct. 5, 1904
	Forsyth, Robert. Cons. Engr., 1159 The Rookery, Chicago, Ill.	May 12, 1875
	Fort, Edwin John. Chf. Engr. of Sewers, 1014 Mechanics Bank Bldg., Brooklyn, N. Y. *(Assoc. M., April 1, 1896)*	Nov. 1, 1904
	Fortin, Sifroy Joseph. Representing Milliken Bros., Apartado 1244, City of Mexico, Mexico. *(Assoc. M., Nov. 6, 1895)*	Dec. 6, 1904
	Foss, Fred Eugene. Prof., Civ. Eng., Cooper Union, New York City	April 1, 1903
	Foss, William Everett. Div. Engr., Met. Water-Works, 1 Ashburton Pl., Boston, Mass.	Mar. 4, 1908
	Foster, Ernest Howard. Vice-Pres., Power Specialty Co., 111 Broadway, New York City	May 6, 1903
	Foster, Wilbur Fisk. 1702 West End Ave., Nashville, Tenn.	May 7, 1873
	Fouquet, John Douglas. Fishkill, N. Y.	June 3, 1885
	Fowler, Charles Evan. Pres. and Chf. Engr., International Contract Co., 501 Central Bldg., Seattle, Wash. *(Jun., May 7, 1890; Assoc. M., Dec. 6, 1893)*	May 3, 1898
	Fowler, Thomas Walker. Civ., Mech. and Elec. Engr., 421 Collins St., Melbourne, Victoria, Australia	Dec. 2, 1903
	Fox, Henry. Chf. Engr., Maryland Dredging & Contr. Co. and Furst Clark Dredging Co. (Res., 2305 Elsinore Ave.), Baltimore, Md.	July 1, 1909
	Fox, John Angell. Special Director, The National Rivers and Harbors Congress of the United States, 204 E. Front St., Cincinnati, Ohio	Feb. 2, 1909
	Fox, Stephenson Waters. Congs. Engr., Kansas City Life Bldg., Kansas City, Mo. *(Jun., July 7, 1880)*	Oct. 6, 1886
	Francis, Charles. 8 Masonic Temple, Davenport, Iowa	May 4, 1892
R.	Francis, George Blinn. Cons. Engr., Westinghouse, Church, Kerr & Co., 10 Bridge St., New York City. *(Jun., Sept. 5, 1883)*	Nov. 7, 1888
	Francis, Henry Newton. Arlington, R. I. *(Jun., Mar. 1, 1876)*	Nov. 7, 1888
	Francis, Walter Joseph. Cons. Engr., Commercial Union Bldg., Montreal, Que., Canada. *(Assoc. M., May 1, 1901)*	April 5, 1904
	Franklin, Benjamin. Cons. Engr. (Franklin & Clarke), 906 Crozer Bldg., Philadelphia, Pa. *(Assoc. M., April 1, 1903)*	June 5, 1906
	Fraser, Charles Edward. Pres., Fraser, Brace & Co., 1328 Broadway, New York City. *(Jun., June 4, 1901; Assoc. M., Sept. 2, 1903)*	June 2, 1908
	Frazier, Harry. Cons. Engr., 412 Am. National Bank Bldg., Richmond, Va.	May 1, 1889
	Frazier, James Lewis. 808 Columbia Bldg., Louisville, Ky.	Sept. 1, 1880
	Frazier, James Welch. (The J. W. Frazier Co.), Rockefeller Bldg., Cleveland, Ohio. *(Assoc. M., May 6, 1903)*	Sept. 5, 1905
	Frederickson, John Henry. Mgr., Western Office, James Stewart & Co., Denver, Colo.	Nov. 1, 1910
	Freeland, Chester Shepard. Chf. Engr., Porterville Northeastern Ry., Porterville, Tulare Co., Cal.	Jan. 3, 1906
N. N.	Freeman, John Ripley. Consulting Hydraulic Engineer; also Pres., Manufacturers Mutual Fire Insurance Co., 815 Banigan Bldg., Providence, R. I. *(Jun., June 7, 1882)*	April 3, 1889
	French, Alexis Henry. Town Engr., Town Hall, Brookline, Mass.	June 6, 1894
	French, Arthur Willard. Prof. of Civ. Eng., Worcester Polytechnic Inst., Worcester, Mass. *(Assoc. M., April 4, 1900)*	Dec. 6, 1904
	French, Frank Chauncey. Cons. Engr., 13 S. & Co. Rd., Salt Lake City, Utah. *(Assoc. M., Dec. 3, 1902)*	Feb. 4, 1908
	French, James Adams. Engr., U. S. Reclamation Service, Engle, N. Mex.	July 1, 1909
	French, James Benton. Cons. Engr., 50 Church St., Room 1276, New York City. *(Jun., Feb. 6, 1889; Assoc. M., Feb. 7, 1894)*	Nov. 2, 1898
	French, Owen Bert. Asst., Coast and Geodetic Survey, Washington, D. C.	April 1, 1903
	Frew, Archibald Smith. Engr. in Chg., Almaden-Etheridge Ry., Charleston, North Queensland, Australia	Oct. 3, 1900
	Freyhold, Felix. 236 First St., S. E., Washington, D. C. *(Assoc. M., Sept. 2, 1891)*	April 2, 1902
	Frink, Ellis Alexander. Bridge Engr., S. A. L. Ry., Portsmouth, Va. *(Assoc. M., June 6, 1900)*	Dec. 4, 1901
	Fritch, Louis Charlton. Chf. Engr., C. G. W. R. R., 468 Grand Central Station, Chicago, Ill.	Oct. 3, 1900
	Fritz, John. 155 Market St., Bethlehem, Pa. *(Hon. M., Sept. 5, 1899)*	July 5, 1893
	Frosell, Carl Gustaf. 523 Jeanette St., Wilkinsburg, Pa.	April 4, 1906
	Fry, Alfred Brooks. Chf. Engr., U. S. Treasury Service; Member, Board of Cons. Engrs., Impvt., State Canals, U. S. Custom House Bldg., New York City	Dec. 6, 1910
	Frye, Albert Irvin. Cons. Engr., 90 West St., New York City	Dec. 2, 1896
	Fuertes, James Hillhouse. Hydr. and San. Engr., 140 Nassau St., New York City. *(Jun., May 2, 1888)*	Feb. 6, 1895

	Date of Membership
FULLER, ALMON HOMER. Prof. of Civ. Eng. and Dean, Coll. of Eng., Univ. of Washington, University Station, Seattle, Wash. (*Jun., April 4, 1899; Assoc., Feb. 4, 1902*)	May 3, 1910
FULLER, FRANK LOUIS. 12 Pearl St., Room 34, Boston, Mass. (*Jun., April 4, 1883*)	April 4, 1888
FULLER, FRANKLIN IDE. Vice-Pres., Portland Ry., Light & Power Co., Electric Bldg., Portland, Ore	Jan. 6, 1886
FULLER, GEORGE WARREN. (Hering & Fuller, Hydr. and San. Engrs.), 170 Broadway, New York City. (*Assoc. M., Mar. 1, 1899*)	May 31, 1904
FULLER, HARRY. Chf. Engr., King Bridge Co., Cleveland, Ohio	Sept. 7, 1904
FULLER, WILLIAM BARNARD. (Johnson & Fuller, Hydr. and San. Engrs.), 150 Nassau St., New York City. (*Jun., June 3, 1885*)	May 1, 1895
FULTON, JAMES EDWARD. Civ. and Mech. Engr., 155 The Terrace, Wellington, New Zealand	Oct. 4, 1910
FULTON, JOHN ADDISON. 934 West Sixth St., Los Angeles, Cal	May 4, 1887
FURBER, WILLIAM COPELAND. Archt. and Cons. Engr., 418 Walnut St., Philadelphia, Pa	May 2, 1899
FURMAN, JOB ROCKFIELD. Chf. Mech. Engr., D. H. Burnham & Co., Chicago, Ill. (*Jun., July 2, 1890*)	Dec. 7, 1904
FYFE, JAMES LINCOLN. Structural Engr., 17 Van Buren St., 907, Chicago, Ill	Oct. 5, 1904
GADD, ROBERT FOSTER. New England Mgr., Levering & Garrigues Co., Steel Contrs., Connecticut Mutual Bldg., Hartford, Conn	Sept. 6, 1910
GADSDEN, GEORGE MORRALL. Pres. of The Gadsden Contr. Co., Savannah, Ga.	May 4, 1898
GAGEL, EDWARD. Chf. Engr., N. Y., N. H. & H. R. R. (Res., 323 Center St.), West Haven, Conn	April 3, 1907
GAHAGAN, WALTER HAMER. Contr. Engr., 189 Montague St., Brooklyn, N. Y. (*Jun., Sept. 5, 1888; Assoc. M., July 1, 1891*)	April 3, 1901
GALLOWAY, JOHN DEBO. (Galloway & Markwart), First National Bank Bldg., San Francisco, Cal	Dec. 6, 1905
GAMBLE, FRANCIS CLARKE. Public Works Engr. and Insp. of Railways, British Columbia, Victoria, B. C., Canada	April 1, 1891
GARDINER, FREDERICK WILLIAM. Prin. Asst. Engr., Interborough Rap. Trans. Co., Manhattan Ry. Div., 32 Park Pl., New York City. (*Assoc. M., Dec. 6, 1899*)	Nov. 2, 1908
GARDINER, JOHN PEDEN. Civ. and Hydr. Engr., 733 Central Bldg., Los Angeles, Cal. (*Assoc. M., Mar. 7, 1906*)	Sept. 6, 1910
GARDNER, EDMUND LEBRETON. Pres., Jersey City Water Supply Co., 158 Ellison St., Paterson, N. J	June 7, 1882
GARDNER, MARTIN LUTHER. Asst. Engr., P. R. R., Jersey City (Res., 66 Milford Ave., Newark), N. J. (*Assoc. M., Sept. 2, 1891*)	Mar. 4, 1896
GARDNER, WILLIAM MONTGOMERY. (*Director*). P. O. Box 1027, Care, U. S. Engr.'s Office, Memphis, Tenn	Dec. 7, 1904
GARLINGHOUSE, FREDERICK LEMAN. Glenshaw, Pa	Mar. 7, 1906
GARRETT, JAMES EDWIN. Asst. Engr., Min. Dept., Cia. M., F. y A. "Monterey," S. A., Apartado No. 283, Monterey, N. L., Mexico	April 5, 1905
GARRETT, JOHN THOMAS. Pres., Missouri Bridge & Iron Co., 1000 Fullerton Bldg., St. Louis, Mo. (*Assoc. M., May 1, 1901*)	Sept. 6, 1910
GARRETT, ROBERT PEEL. Vice-Pres. and Treas., Missouri Bridge & Iron Co., 1000 Fullerton Bldg., St. Louis, Mo. (*Jun., Jan. 4, 1898; Assoc. M., Oct. 2, 1901*)	Mar. 5, 1907
GARRISON, EVERETT. Cons. Engr., Newburgh, N. Y	Mar. 7, 1894
GARRISON, FRANK LYNWOOD. Min. Engr., 760 Drexel Bldg., Philadelphia, Pa. (*Assoc. M., Sept. 7, 1892*)	Mar. 5, 1907
GASTON, LOUIS PREVOST. (Richards & Gaston), 143 Liberty St., New York City	Feb. 1, 1905
GATES, CHRISTOPHER LAWRENCE. Cons. Engr., 416 Irving St., Toledo, Ohio. (*Jun., Dec. 4, 1878*)	Sept. 5, 1883
GATES, HORACE DELPHOS. Asst. in Office of City Engr., City Engr.'s Office, San Francisco, Cal	Mar. 7, 1883
GAULT, HOMER JOHNSTON. Constr. Engr., U. S. Reclamation Service, Elephant Butte, N. Mex	Oct. 2, 1907
GAUT, ROBERT EUGENE. With Leonard Constr. Co., 1937 McCormick Bldg., Chicago, Ill	April 3, 1907
GAY, CHARLES WEBSTER. 25 Exchange St., Lynn, Mass	May 6, 1891
GAY, MARTIN. Asst. Engr., Dept. of Bridges, City of New York, 103 East 125th St., New York City. (*Jun., June 4, 1884*)	June 5, 1889
GAYLER, CARL. 900 Wainwright Bldg., St. Louis, Mo	Sept. 3, 1884
GAYOL, ROBERTO. Cons. Engr.; Chf. Engr. of the Sauteña Irrig. Works, P. O. Box 766, City of Mexico, Mexico.	Mar. 2, 1892
GAZLAY, WEBSTER. Engr. and Vice-Pres., National Concrete Constr. Co., Board of Trade Bldg., Louisville, Ky	June 7, 1905
GEDDES, EDMOND BURNS. U. S. Asst. Engr., Natchez, Miss	Mar. 2, 1898

		Date of Membership
	GEDDES, JAMES KENNON. Gen. Mgr., Ohio River & Western Ry. Co., Zanesville, Ohio	Jan. 2, 1890
	GEER, HARVEY MOSHER. Ballston, N. Y.	June 6, 1894
	GEHLER, GUSTAV WILLY. Chf. Engr., Vice-Pres. and Mgr., Tech. Div. of Firm, Dyckerhoff & Widmann, Kurfurstenstr. 1, Dresden, Germany	April 5, 1910
	GEMMELL, ROBERT CAMPBELL. Asst. Gen. Mgr., Utah Copper Co., Bingham & Garfield Ry. Co., Ray Consolidated Copper Co., and Chino Copper Co., Salt Lake City, Utah. (*Assoc. M., Oct. 5, 1892*)	Dec. 4, 1895
	GERBER, EMIL. Asst. to Pres., Am. Bridge Co., Frick Bldg., Pittsburg, Pa.	Feb. 1, 1888
	GERIG, WILLIAM. Vice-Pres. and Chf. Engr., Pac. & Eastern Ry., Medford, Ore	Mar. 5, 1902
	GERRY, MARTIN HUGHES, JR. Chf. Engr. and Gen. Mgr., Missouri River Power Co., Helena, Mont. (*Assoc. M., June 6, 1900*)	Dec. 3, 1902
	GESSNER, GUSTAVUS ADOLPHUS, JR. Res. Engr., Cherry St. Bridge Constr. (Res., 2465 Scottwood Ave.), Toledo, Ohio. (*Assoc. M., April 2, 1902*)	Oct. 3, 1905
	GESTER, WILLIAM BURR. Pacific Coast Representative, Robert W. Hunt & Co., 418 Montgomery St., San Francisco, Cal	Oct. 4, 1910
	GETMAN, FRANK LAWTON. Cons. Engr. and Mfrs. Representative; (Keene & Getman), 438 Lonja de Comercia, Havana, Cuba. (*Assoc. M., April 5, 1905*)	May 4, 1909
	GIBBS, GEORGE. Chf. Engr., Elec. Traction and Station Constr., P. T. & T. R. R. Co., Pennsylvania Station, 7th Ave. and 32d St., New York City.	Mar. 6, 1895
	GIBSON, JAMES EDWIN. Prin. Asst. Engr., Am. Pipe & Constr. Co., 112 North Broad St., Philadelphia, Pa	Sept. 6, 1910
	GIDDINGS, FREDERICK. Atchison, Kans	June 6, 1906
	GIFFORD, GEORGE EDWIN. Vice-Pres., The Bowles-Gifford Co., 25 East 26th St., Room 1214, New York City. (*Assoc. M., Oct. 7, 1891*)	Jan. 1, 1896
	GIFFORD, ROBERT LADD. Pres., Illinois Eng. Co., Monadnock Bldg. (Res., 4908 Kimbark Ave.), Chicago, Ill. (*Assoc. M., May 6, 1903*)	June 4, 1907
	GILES, ROBERT. 59 West 45th St., New York City	May 6, 1891
	GILFILLAN, GEORGE AIKEN. Cons. Engr., 341 Fourth Ave., Pittsburg, Pa.	Dec. 6, 1905
	GILLESPIE, RICHARD HENWOOD. Chf. Engr., Sewers and Highways, Bronx, 177th St. and Third Ave. (Res. 2774 Briggs Ave., Bedford Park), New York City. (*Assoc. M., Oct. 3, 1900*)	June 5, 1906
	GILLETTE, EDWARD. Supt., Sheridan Div., C., B. & Q. Ry., Sheridan, Wyo.	July 3, 1889
	GILLETTE, HALBERT POWERS. Editor, *Engineering-Contracting*, 355 Dearborn St., Room 904, Chicago, Ill	May 4, 1904
	GILLETTE, LEWIS SINGER. Pres., Elec. Steel Elevator Co., Minneapolis, Minn.	June 7, 1899
	GILMAN, JAMES BEATTY. Chf. Engr., Minneapolis Steel & Machinery Co., Minneapolis, Minn	Oct. 7, 1908
	GLADDING, HENRY HOLBROOK. Asst. City Engr., 30 Stanley St., New Haven, Conn. (*Jun., July 1, 1885*)	Jan. 4, 1888
	GLASGOW, ARTHUR GRAHAM. (Humphreys & Glasgow), 38 Victoria St., Westminster, London, England	Jan. 3, 1900
	GLAZIER, WILLIAM LEONARD. Engr. and Supt. of Water-Works, Newport, Ky. (*Assoc. M., Oct. 7, 1903*)	Mar. 5, 1907
	GODDARD, LESLIE WARREN. U. S. Asst. Engr., U. S. Engr. Office, Grand Rapids, Mich. (*Assoc. M., Mar. 2, 1892*)	Oct. 6, 1908
	GODFREY, EDWARD. Structural Engr. (Robert W. Hunt & Co.), Monongahela Bank Bldg., Pittsburg, Pa	Oct. 5, 1909
	GOETHALS, GEORGE WASHINGTON. Chairman and Chf. Engr., Isthmian Canal Comm., Culebra, Canal Zone, Panama	Mar. 1, 1910
	GOING, ALVAH SEYMOUR. Locating Engr., G. T. Ry. System, 407 G. T. Ry. Bldg., Montreal, Que., Canada. (*Assoc. M., May 4, 1892*)	June 7, 1899
R.	GOLDMARK, HENRY. Designing Engr., Isthmian Canal Comm., Culebra, Canal Zone, Panama. (*Jun., May 7, 1884*)	June 6, 1888
	GOODALE, LOOMIS FARRINGTON. Superv. Railway Expert to the Govt. of the Philippine Islands, Manila, Philippine Islands	Nov. 7, 1900
	GOODNOUGH, XANTHUS HENRY. Chf. Engr., State Board of Health, Room 140, State House, Boston, Mass. (*Assoc. M., May 6, 1896*)	June 4, 1902
C.	GOODRICH, ERNEST PAYSON. Cons. Engr., 2 Rector St., New York City. (*Jun., April 3, 1900*)	Nov. 1, 1905
	GOODRICH, WILBUR FRANCIS. Cons. Engr., 10 Gibbens St., Somerville, Mass.	May 4, 1887
	GOODWIN, GEORGE ESTYN. Supt., Dalles-Celilo Canal, U. S. Engrs., War Dept., The Dalles, Ore. (*Assoc. M., Jan. 8, 1908*)	July 1, 1909
	GOODWIN, JAMES BOWMAN. Chf. Field Engr. and Supt., Constr., Mount Hood Ry. & Power Co., Bull Run, Ore	Dec. 4, 1907
	GORDON, CHARLES EDWARD. Care, Dept. of Public Works, Manila, Philippine Islands	Sept. 6, 1905
	GOTSHALL, WILLIAM CHARLES. 1 West 72d St., New York City	May 7, 1902
	GOULD, HARRY MADERA. Vice-Pres. and Gen. Mgr., Foster-Creighton-Gould Co., Engrs. and Gen. Contrs., 3 Berry Blk., Nashville, Tenn.	Nov. 30, 1909

		Date of Membership
	Gould, William Tillotson. Asst. Engr., Penn. T. & T. R. R. Co., 140 Third St., Long Island City (Res., Hastings-on-Hudson), N. Y.	Jan. 2, 1890
	Gove, William Granville. Supt. of Equipment, Brooklyn Rapid Transit System, 85 Clinton St., Brooklyn, N. Y. (*Assoc. M., Feb. 3, 1904*)	Feb. 1, 1910
	Govern, Edward James. Div. Engr., Western Div., State of New York, 939 Granite Bldg., Rochester, N. Y.	Jan. 8, 1908
	Grace, Arthur M. Chf. Engr., Southern Alberta Land Co., Ltd., Medicine Hat, Alta., Canada	July 1, 1909
	Grady, Charles Benedict. Asst. Mech. Engr., New York Edison Co., 55 Duane St., New York City. (*Assoc. M., Sept. 6, 1905*)	Aug. 31, 1909
	Grafton, Charles Edwin. New Cumberland, W. Va.	Jan. 1, 1896
	Graham, Charles Hallett. 352 East 201st St., New York City	Sept. 7, 1887
	Granbery, Julian Hastings. 20 Broad St., New York City. (*Jun., Sept. 6, 1898; Assoc. M., Sept. 2, 1903*)	April 6, 1909
	Grant, Emerson Warren. Asst. Engr., A., T. & S. F. Ry. Co., 24th and Topeka Ave., Topeka, Kans.	Dec. 4, 1889
	Grant, Justus Herbert. Contr. Engr., 78 South Goodman St., Rochester, N. Y.	Mar. 2, 1892
	Grant, William. (Grant & Letton), 401 F. & M. Bldg., Lincoln, Nebr.	Feb. 1, 1910
	Grantham, Herbert Thomas. Chf. Engr., Belmont Iron Works, 1622 Real Estate Trust Bldg., Philadelphia, Pa. (*Assoc. M., Feb. 5, 1896*)	May 7, 1902
	Graves, Edwin Dwight. Address unknown. (*Assoc. M., Jan. 2, 1895*)	Dec. 2, 1896
	Graves, Walter Hayden. Box 298, Portland, Ore.	Feb. 2, 1909
	Graves, Walter Joseph. U. S. Engr. Office, Sault Ste. Marie, Mich. (*Assoc. M., July 9, 1906*)	Jan. 4, 1910
	Gray, George Edward. Cons. Engr., 2945 Magnolia St., Glenwood Park, Berkeley, Cal. (*Hon. M., June 5, 1894*)	July 2, 1873
	Gray, John Henry. Pres., J. H. Gray Co., 2019 Fuller Bldg., New York City.	Oct. 2, 1895
	Gray, Samuel Merrill. Cons. Engr., Providence, R. I.	May 15, 1872
	Green, Bernard Lincoln. Vice-Pres., The Osborn Eng. Co., Osborn Bldg., Cleveland, Ohio	April 3, 1901
	Green, Bernard Richardson. Supt., Building and Grounds, Library of Congress, Washington, D. C.	Oct. 2, 1889
	Green, Hubert Edward. Res. Engr., Riverside Groves & Water Co., 631 Central Bldg., Los Angeles, Cal.	Dec. 2, 1903
	Green, Samuel Martin. Cons. Engr., 318 Main St., Springfield, Mass.	July 1, 1908
	Greene, Francis Vinton. Pres., Niagara, Lockport & Ontario Power Co., Fidelity Bldg., Buffalo, N. Y.	June 3, 1885
	Greene, George Sears, Jr. Cons. Engr., 11 Broadway, New York City	Dec. 4, 1867
	Greene, Robert Maxson. Asst. Engr., Am. Bridge Co., Ambridge, Pa. (*Assoc. M., June 1, 1898*)	Sept. 1, 1908
R.	Gregory, John Herbert. Engr., Met. Sewerage Comm. of New York, 17 Battery Pl., New York City. (*Jun., Jan. 3, 1899; Assoc. M., April 3, 1901*)	Dec. 4, 1906
	Gregory, Luther Elwood. Civ. Engr., U. S. N., U. S. Navy Yard, Portsmouth, N. H.	April 6, 1904
	Gregory, William Benjamin. Prof. of Experimental Eng., Tulane Univ.; Irrig. Engr., U. S. Dept. of Agriculture, 630 Pine St., New Orleans, La.	Nov. 8, 1909
N.	Greiner, John Edwin. Cons. Engr., Continental Bldg., Baltimore, Md.	June 4, 1890
	Gresham, Robert Hall. Chf. Engr., Asherton & Gulf Ry., 724 West Poplar St., San Antonio, Tex.	May 4, 1898
	Griffin, William Reid Wesley. Gen. Mgr., Ohio Val. Scenic Route, East Liverpool, Ohio	Feb. 5, 1908
	Griggs, Julian. Chf. Engr., Lancaster Traction & Power Co., 1318 Forsythe Ave., Columbus, Ohio	Oct. 4, 1899
	Grimes, Edwin Lincoln. City Engr., City Hall, Troy, N. Y.	Mar. 2, 1904
	Grimm, Carl Robert. Standish Arms, Brooklyn, N. Y.	June 4, 1890
	Grimshaw, James Walter. St. Stephen's Club, Westminster, London, S. W., England	Nov. 7, 1888
	Grossart, Lewis John Henry. Town Engr., Northampton and Catasauqua, Pa., Room 423, Commonwealth Bldg., Allentown, Pa.	May 1, 1907
N.	Grunsky, Carl Ewald. Pres., Am. Eng. Corporation, Mechanics Inst. Bldg., San Francisco, Cal.	Oct. 5, 1898
	Gumaer, Edward Bennet. Allenhurst, N. J.	Sept. 6, 1905
	Gunn, William Edward. Middlesboro, Ky.	April 5, 1905
	Gunnell, William Covington. Cosmos Club, 1520 H St., N. W., Washington, D. C.	Feb. 7, 1877
	Guppy, Benjamin Wilder. Engr. of Bridges and Bldgs., B. & M. R. R., North Station, Boston, Mass. (*Jun., June 19, 1891; Assoc. M., Oct. 3, 1894*)	Feb. 6, 1901
	Gutelius, Frederick Passmore. Gen. Supt., Canadian Pacific Ry., Montreal, Que., Canada	Oct. 3, 1906
	Guthrie, Edward Buckingham. Chf. Engr., Grade Crossing Comm., 436 Ellicott Sq. (Res., 562 West Ferry St.), Buffalo, N. Y. (*Assoc., Sept. 3, 1884*)	Oct. 5, 1887

	Date of Membership
Haas, Edward Francis. Merchants Exchange Bldg., San Francisco, Cal. (*Jun., Feb. 6, 1894; Assoc. M., Sept. 5, 1900*)	Feb. 6, 1906
Hackney, John Wesley. (Ashmead & Hackney), 622 Bartlett Bldg., Atlantic City, N. J.	Oct. 5, 1909
Hadsall, Harry Hugh. Gen. Supt., Leonard Constr. Co., Room 1937, McCormick Bldg., Chicago, Ill.	Mar. 6, 1907
Hague, Charles Arthur. Cons. Engr., 52 Broadway, New York City	Feb. 3, 1892
Haight, Horace De Remer. Engr. for Thos. Prosser & Son, 15 Gold St., New York City (Res., 1008 St. John's Pl., Brooklyn, N. Y.) (*Jun., May 1, 1900; Assoc. M., Feb. 4, 1903*)	Jan. 31, 1911
Haight, Stephen Samuel. Civ. Engr. and City Surv., 64 Buchanan Pl., University Heights, New York City	June 1, 1881
Haines, Caspar Wistar. 322 Arcade Bldg., Philadelphia, Pa. (*Jun., Feb. 2, 1876*)	Oct. 7, 1891
Haines, Eugene Grove. Asst. Engr., Public Service Comm., First Dist., New York City, 23 Flatbush Ave., Brooklyn, N. Y. (*Assoc. M., May 1, 1901*)	April 5, 1910
Haines, Henry Stevens. Villa Gascoyne, Alassio, Italy	Nov. 2, 1887
Hains, Peter Conover. Brig.-Gen., U. S. A. (*Retired*); Cons. Engr., Union Trust Bldg., Washington, D. C.	April 2, 1890
Hale, Richard Augustus. Prin. Asst. Engr., Essex Co., Lawrence, Mass. (*Jun., Feb. 6, 1884*)	July 1, 1891
Hall, Benjamin Mortimer. Cons. Engr.; Gen. Mgr., Amicalola Marble Co., Atlanta, Ga.	Feb. 6, 1901
Hall, Henry Arthur. 2411 North Proctor St., Tacoma, Wash.	May 7, 1902
Hall, John Lincoln. Second Vice-Pres., Purdy & Henderson, 1142 Henry Bldg., Seattle, Wash.	July 10, 1907
Hall, Julien Astin. Cons. Engr., Wenonda, Pittsylvania Co., Va.	June 5, 1889
N. Hall, William Hammond. Cons. Engr., 324 Haight St., San Francisco, Cal.	Jan. 2, 1884
Hall, William McLaurine. Union Trust Bldg., Parkersburg, W. Va.	Dec. 6, 1893
Hallihan, John Philip. Care, Chas. B. Eddy, 68 William St., New York City. (*Assoc. M., April 4, 1900*)	June 5, 1906
Hallock, James Currie. Deputy Chf. Engr., Dept. of Public Works, City Hall, Newark, N. J.	Oct. 3, 1906
Hallsted, James Cottle. Cons. Engr., 1121 The Rookery, Chicago, Ill.	Jan. 4, 1905
Ham, William Hale. Cons. Engr., Albany Bldg., Boston, Mass. (*Assoc. M., Nov. 5, 1902*)	Sept. 3, 1907
Hambleton, Francis Henry. Cons. Engr., Consolidated Gas Co., Baltimore, Md.	Mar. 5, 1873
Hamilton, Frank Henry. City Engr. and Commr. of Bldgs., City Hall, Springfield, Ill.	June 30, 1910
Hamilton, John Wilson. (Hamilton & Chambers, Engrs. and Contrs.), 29 Broadway, New York City	July 10, 1907
Hamilton, William Gaston. 105 East 21st St., New York City	Oct. 7, 1868
Hamlin, George Herbert. Bangor, Me.	July 3, 1895
Hamlin, Homer. City Engr., Los Angeles, Cal.	May 4, 1904
Hammatt, Edward Augustus White. Cons. Engr., Hyde Park, Mass.	June 5, 1901
Hammatt, William Cushing. Chf. Engr., Miller & Lux, Inc., and San Joaquin & Kings River Canal & Irrig. Co., Inc., 1313 Merchants Exchange, San Francisco, Cal. (*Assoc. M., Sept. 5, 1900*)	Oct. 5, 1909
Hammond, Alonzo John, Chf. Engr., Bureau of Public Efficiency of Chicago; Cons. Engr., Suite 207, Summers Bldg., South Bend, Ind.	June 1, 1904
Hammond, Charles Adrian. Mgr., Mt. Vernon Sewage Disposal Works, Columbus Ave., Foot of 7th St. (Res., 301 South 4th Ave.), Mt. Vernon, N. Y.	April 6, 1909
Hammond, Charles Lincoln. Engr., Conners Bros. Co. (Res., 69 Forrest St.), Lowell, Mass.	May 3, 1910
Hammond, George Tillinghast. 156 Berkeley Pl., Brooklyn, N. Y.	Feb. 7, 1906
Hammond, John Farnsworth. Cons. Engr., 123 Oak St., Richmond Hill, N. Y.	Feb. 7, 1906
Hancock, Robert Rives. Secy. of The Philippine Ry. Co., 43 Exchange Pl., New York City	Dec. 1, 1908
Hand, Franklin Clark. Chf. Engr., Oklahoma Central Ry., Purcell, Okla.	Feb. 6, 1907
Handbury, Thomas Henry. Col., Corps of Engrs., U. S. A. (*Retired*), Care, Hong Kong-Shanghai Banking Corporation, Tientsin, China	Feb. 3, 1904
Hanna, John Hunter. Chf. Engr., The Capital Traction Co., 36th and M Sts., Washington, D. C. (*Assoc. M., April 3, 1901*)	Nov. 1, 1904
Hanna, John Venable. Chf. Engr., Kansas City Terminal Ry. Co., 23d and Grand Ave., Kansas City, Mo. (*Assoc. M., May 3, 1893*)	April 2, 1902
Hansel, Charles. Pres., Charles Hansel & Co., 43 Wall St., New York City.	Oct. 3, 1894
Hansen, Andrew Christian. Mojave, Cal.	Oct. 4, 1910
Hara Aiyar, Narayana Pranatarti. Address unknown	Dec. 5, 1906
Harahan, William Johnson. Asst. to Pres., Erie R. R., 50 Church St., New York City. (*Assoc. M., Oct. 3, 1894*)	Oct. 7, 1903
Hardaway, Benjamin Hurt. Contr. Engr., Columbus, Ga.	Oct. 7, 1903

		Date of Membership
	Hardee, William Joseph. City Engr., Room 19, City Hall, New Orleans, La.	May 6, 1896
	Harding, Chester. Maj., Corps of Engrs., U. S. A., Gatun, Canal Zone, Panama	Oct. 4, 1905
	Harding, James Judson. Gen. Delivery, Long Beach, Cal	Feb. 6, 1907
	Hardy, Edward Dana. Supt. of Washington Aqueduct and Filtration Plant, Washington, D. C	Oct. 5, 1904
	Hardy, George Fiske. 309 Broadway, New York City	Mar. 1, 1905
	Hardy, Harry. Cristobal, Canal Zone, Panama. *(Assoc. M., June 1, 1892)*	June 1, 1909
	Haring, Alexander. Prof. of Bridge and Railway Eng., New York Univ., 2251 Aqueduct Ave., University Heights, New York City	April 4, 1906
	Haring, James Smith. 35 Bradford Ave., Crafton, Pa	Nov. 4, 1891
	Harkness, George Edward. Constr. Engr., Holbrook, Cabot & Rollins, 6 Beacon St., Boston, Mass	June 1, 1909
	Harley, Alfred Francis. Cons. Engr., 136 East Bay St., Jacksonville, Fla	Dec. 7, 1898
	Harlow, George Richardson. 204 Hawthorn St., Edgewood, Swissvale P. O., Pa	Nov. 1, 1899
	Harlow, James Hayward. Chf. Engr., Susquehanna Power Co., Darlington, Md	Mar. 4, 1874
	Harman, Eugene Leonard. U. S. Asst. Engr. with Miss. River Comm., 1307 Liggett Bldg., St. Louis, Mo	Oct. 3, 1906
	Harper, Edgar Ambler. 429 W. 11th St., Kansas City, Mo	June 7, 1905
	Harper, John Lyell. Chf. Engr., Hydr. Power Co. and Cliff Elec. Distributing Co., Niagara Falls, N. Y	June 5, 1907
	Harrington, Ephraim. Cons. and Advisory Engr., 20 Pemberton Sq., Boston, Mass	Mar. 3, 1897
	Harrington, Ferdinand Finney. Engr. of Structures, Virginian Ry. Co., Norfolk, Va. *(Assoc. M., May 3, 1899)*	Feb. 2, 1909
	Harrington, John Lyle. (Waddell & Harrington, Cons. Engrs.), 1012 Baltimore Ave., Kansas City, Mo. *(Jun., Aug. 31, 1897; Assoc. M., Oct. 4, 1899)*	Dec. 1, 1903
	Harris, Elmo Golightly. Prof. of Civ. Eng., Mo. School of Mines, Rolla, Mo	Oct. 2, 1901
	Harris, Frederic Robert. Corps of Civ. Engrs., U. S. N.; Civ. Engr. in Chg., U. S. Navy Yard, Brooklyn, N. Y	June 30, 1910
	Harris, Stephen. 7217 Boyer St., Mt. Airy, Philadelphia, Pa	June 4, 1902
	Harris, Van Alen. Const. Engr., Central Fortuna, Ponce, Porto Rico. *(Jun., Nov. 6, 1894; Assoc. M., Oct. 5, 1898)*	Sept. 6, 1904
R.	Harrison, Charles Lewis. 7 East 42d St., New York City	Mar. 2, 1898
	Harrison, Edlow Wingate. Cons. Engr.; Chf. Engr., Passaic Val. Sewerage Commrs., 15 Exchange Pl., Jersey City, N. J	June 3, 1885
	Harrison, Edmund Pendleton Hunter. Vice-Pres., Eyre-Shoemaker, Inc., 900 Arcade Bldg., Philadelphia, Pa	May 1, 1907
	HARROD, BENJAMIN MORGAN. *(Past-President)*. Cons. Engr., 1637 Foucher St., New Orleans, La	April 4, 1877
	Harroun, Philip Embury. Hydr. Engr., Berkeley, Cal	Mar. 7, 1900
	Harte, Charles Rufus. Asst. Engr., N. Y., N. H. & H. R. R., Room 308, R. R. Bldg., New Haven, Conn. *(Jun., April 4, 1899; Assoc. M., May 2, 1900)*	Nov. 5, 1907
	Hartigan, Frederick Lawrence. 701 West 179th St., New York City. *(Assoc. M., May 6, 1903)*	Mar. 31, 1908
	Hartman, Russell Theodore. Care, Des Moines Bridge & Iron Works, Des Moines, Iowa. *(Assoc. M., May 4, 1909)*	Nov. 1, 1910
	Hartrick, Edward Macaulay. U. S. Asst. Engr., River and Harbor Impvts., Galveston, Tex	Feb. 1, 1899
R.	Harts, William Wright. Maj., Corps of Engrs., U. S. A., Custom House, Nashville, Tenn. *(Assoc. M., Oct. 2, 1895)*	April 6, 1898
	Hartwell, Harry. Asst. Engr., Sanderson & Porter, 52 William St., New York City. *(Jun., Jan. 2, 1894; Assoc. M., Feb. 2, 1898)*	Jan. 3, 1907
	Hartwell, Herbert Clifford. Asst. Engr., Bost. Elev. Ry. Co., 101 Milk St., Boston, Mass	Oct. 7, 1908
	Harwood, George Alec. Chf. Engr., Electric Zone Impvts., N. Y. C. & H. R. R. R., 335 Madison Ave., Room 1206, New York City. *(Assoc. M., Feb. 5, 1902)*	Feb. 5, 1907
	Harwood, Thomas Triplett Hunter. Asst. Engr., U. S. Engr. Office, 25 Pemberton Sq., Boston, Mass	April 5, 1910
	Haskell, Eugene Elwin. Director, Coll. of Civ. Eng., Cornell Univ., Ithaca, N. Y	Sept. 7, 1898
	Haskins, William Jewett. Cons. Engr. and Contr., 50 Church St., Room 469, New York City. *(Jun., Mar. 7, 1883)*	Dec. 1, 1886
	Haslam, Erwin Ernest. Civ. and Hydr. Engr., Hotel Columbia, Columbia, Pa	July 1, 1909
	Hasskarl, Joseph Frederick. Director, Dept. of Wharves, Docks and Ferries (Res., 1603 Girard Ave.), Philadelphia, Pa. *(Assoc. M., Mar. 5, 1902)*	Nov. 1, 1904

	Date of Membership
Hastings, Frank Arnold. Cons. Engr., Wheeling, W. Va. (Res., Martins Ferry, Ohio.) *(Assoc. M., Dec. 3, 1902)*	May 31, 1910
Hatch, Frederick Thomas. Chf. Engr., Vandalia R. R., 850 Century Bldg., St. Louis, Mo.	Dec. 4, 1889
Hatch, James Noble. Structural Engr. for Sargent & Lundy, 1720 Railway Exchange, Chicago, Ill.	Dec. 7, 1904
Hatton, Thomas Chalkley. Cons. Engr., Wilmington, Del.	Mar. 6, 1895
Haugh, James Charles. Res. Engr., New Orleans & North Eastern R. R., Press and Levee Sts., New Orleans, La.	Feb. 2, 1909
Haupt, Lewis Muhlenberg. Cons. Engr., 107 North 35th St., Philadelphia, Pa.	June 6, 1888
Haven, William Appleton. 812 Potomac Ave., Buffalo, N. Y.	Mar. 5, 1873
Haviland, Arthur. Engr., Land and Tax Dept., N. Y. C. & H. R. R. R. Co., 335 Madison Ave., Room 1102, New York City. *(Jun., Jan. 4, 1882)*	Jan. 4, 1888
Hawgood, Harry. Cons. Engr., 722 H. W. Hellman Bldg., Los Angeles, Cal.	May 4, 1909
Hawks, James Dudley. Pres., Detroit & Mackinac Ry., Majestic Bldg., Detroit, Mich.	Dec. 3, 1884
Hawksley, Kenneth Phipson. Caxton House, Westminster, S. W., London, England	May 6, 1903
Hawley, John Blackstock. Cons. Engr., Fort Worth, Tex. *(Assoc. M., May 1, 1895)*	Oct. 5, 1898
Hawley, William Chauncey. Chf. Engr. and Gen. Supt., Pennsylvania Water Co., 701 Wood St., Wilkinsburg, Pa. *(Jun., Oct. 1, 1890; Assoc. M., April 6, 1892)*	Dec. 3, 1902
Hawxhurst, Robert, Jr. Cons. Engr., 623 Salisbury House, London, E. C., England. *(Assoc. M., Sept. 7, 1904)*	Dec. 3, 1907
Hayden, John Bruce. 376 Genesee St., Utica, N. Y. *(Assoc. M., May 2, 1900)*	May 5, 1908
Hayden, William Wallace. Chf. Engr., Lake View Traction Co., N. Memphis Savings Bank, Memphis, Tenn.	Nov. 6, 1895
Hayes, Edmund. 816 Fidelity Bldg., Buffalo, N. Y. *(Jun., April 3, 1878)*	Mar. 5, 1884
Hayes, Edward. Cons. Engr., 113 Dryden Rd., Ithaca, N. Y.	June 5, 1901
Hayes, George Samuel. 1123 Broadway, New York City. *(Jun., Dec. 6, 1892; Assoc. M., June 3, 1896)*	Sept. 2, 1903
Hayes, Henry Wilde. Mass. Engr. of Grade Crossings, 8 Beacon St., Boston, Mass. *(Assoc. M., Mar. 2, 1898)*	May 1, 1901
Hayes, Stanley Wolcott. Pres., Hayes Track Appliance Co., Geneva, N. Y.	June 6, 1900
Hayford, John Fillmore. Director, Coll. of Eng., Northwestern Univ., Evanston, Ill. *(Assoc. M., May 6, 1896)*	April 2, 1907
Hays, John Willis. 3 South Adams St., Petersburg, Va.	June 5, 1901
Hayt, Robert Olcott. Asst. Engr., U. S., Reclamation Service, P. O. Box 551, Helena, Mont. *(Assoc. M., Oct. 3, 1906)*	June 30, 1910
Hayt, Stephen Thurston, Jr. Chf. Engr., Susq. & N. Y. R. R. Co., 11 Trinity Pl., Williamsport, Pa.	Mar. 3, 1897
Hayward, Robert Francis. Gen. Mgr., Western Canada Power Co., Ltd., Vancouver, B. C., Canada	July 10, 1907
Hazard, Schuyler. Gen. Mgr. and Chf. Engr., Orleans County Quarry Co., Albion, N. Y.	Oct. 5, 1898
Hazelton, Charles William. Engr. and Treas., Turners Falls Co. (Water Power), Turners Falls, Mass.	Jan. 7, 1891
R. **Hazen, Allen.** (Hazen & Whipple, Cons. Engrs.), 103 Park Ave., New York City. *(Assoc. M., June 3, 1896)*	Mar. 6, 1900
Hazen, William Nelson. Engr. for Am. Concrete Steel Co., Union Bldg., Newark, N. J. *(Assoc. M., Dec. 3, 1902)*	Nov. 8, 1909
Hazlehurst, George Blagden. Cons. Engr., Catonsville, Md.	Feb. 1, 1888
Hazlehurst, James Nisbet. Cons. Engr., 532 Candler Bldg., Atlanta, Ga.	Oct. 4, 1899
Heald, Simpson Clark. Rockwood St., Jamaica Plain, Mass.	Nov. 4 1885
Healy, John Francis. Gen. Mgr., Operating Dept., Davis Colliery Co., Elkins, W. Va. *(Jun., Jan. 2, 1890; Assoc. M., June 3, 1891)*	Nov. 1, 1899
Heckle, George Rogers. Oella, Baltimore Co., Md. *(Assoc. M., Feb. 7, 1906)*	Jan. 3, 1911
Hedges, Samuel Hamilton. Pres., Puget Sound Bridge & Dredging Co., 432 Central Bldg., Seattle, Wash.	July 10, 1907
Hedrick, Ira Grant. (Hedrick & Cochrane. Cons. Engrs.), 1118 McGee St., Kansas City, Mo. *(Jun., Oct. 3, 1893; Assoc. M., June 2, 1897)*	Nov. 7, 1900
Hegardt, Gustave Bernard. (Hegardt & Clarke), 1010 Board of Trade Bldg., Portland, Ore.	Oct. 7, 1908
Heldt, Hans Ludwig. Supt., The Sombrerete Min. Co., Sombrerete, Zac., Mexico	June 5, 1907
Hench, Norman MacPherson. Engr., Track Appliances, Carnegie Steel Co., Carnegie Bldg., Pittsburg, Pa.	May 2, 1906
Henderer, William Oswald. Pres., The Osborn Eng. Co., Osborn Bldg., Cleveland, Ohio	April 3, 1901

		Date of Membership
	Henderson, John Baillie. Govt. Hydr. Engr., Water Supply Dept., Brisbane, Queensland, Australia	June 4, 1890
	Henderson, John Thomas. Deputy Chf. Engr., Conn. River Bridge and Highway Dist., 756 Main St., Hartford, Conn. (*Assoc. M., Sept. 3, 1902*)	Sept. 3, 1907
	Hendrick, Calvin Wheeler. Chf. Engr., Baltimore Sewerage Comm., American Bldg., Baltimore, Md	Nov. 7, 1900
	Hengst, Robert Graham. Mgr. for Jno. B. Carter Co., R. R. Builders; Res., 193 Wallace Ave., New Castle, Pa. (*Assoc. M., Oct. 7, 1903*)	May 5, 1908
	Henny, David Christiaan. Cons. Hydr. Engr., 605 Spalding Bldg., Portland, Ore	Sept. 7, 1887
	Henry, George Jackson, Jr. Hydr. and Mech. Engr., 19th and Harrison Sts., San Francisco, Cal	April 5, 1910
	Henry, Philip Walter. Cons. Engr., 25 Broad St., New York City. (*Assoc. M., Jan. 3, 1894*)	Nov. 2, 1908
	Hepburn, Frederick Taylor. Gen. Mgr., Saginaw Power Co., Saginaw City Gas Co., Bay City Power Co., Saginaw-Bay City Ry., and Bay City Gas Co. (Res., 608 South Jefferson Ave.), Saginaw, Mich	June 6, 1906
	Herbert, Arthur Powis. Apartado 67, Colima, Colima, Mexico	Sept. 5, 1888
	Herbert, Harry Monmouth. Cons. Engr.; Member, New Jersey State Board of Health; Chf., Div. of Sewerage and Water Supplies, Bound Brook, N. J	April 6, 1898
	Hering, Rudolph. Hydr. and San. Engr., 170 Broadway, New York City.	Jan. 5, 1876
	Hermann, Edward Adolph. Pres., Reliance Quarry & Constr. Co., 1026 Langdon St., Alton, Ill	April 6, 1887
	Herrick, Henry Augustus. Hydr. and Mill Engr., 45 Milk St., Boston, Mass. (Res., 242 Prospect St., Manchester, N. H.)	May 7, 1890
	Herring, Willard E. Dist. Engr., U. S. Forest Service, Portland, Ore. (*Assoc. M., Sept. 4, 1901*)	Jan. 3, 1907
	Herrmann, Frederick Charles. Constr. Engr., Spring Val. Water Co., 375 Sutter St., San Francisco, Cal	Nov. 6, 1907
	Herron, John. Box 463, Palo Alto, Cal	Oct. 4, 1893
R.	Herschel, Clemens. Hydr. Engr., 2 Wall St., New York City	April 21, 1869
	Hesse, Fred. 471 East Alder St., Portland, Ore	June 3, 1908
	Heuer, William Henry. Col., Corps of Engrs., U. S. A. (*Retired*), 851 Pacific Bldg., San Francisco, Cal	Mar. 3, 1880
	Hewes, Virgil Henry. Mgr. and Treas., The Zwoyer Fuel Co., 60 Wall St., Room 2602 (Res., 161 West 103d St.), New York City	Feb. 3, 1904
	Hewett, Bertram Henry Majendie. Care, Jacobs & Davies, 30 Church St., New York City. (*Assoc. M., April 5, 1905*)	Oct. 1, 1907
	Hewett, William Sherman. Box 1004 Minneapolis, Minn	June 1, 1909
	Hewins, George Sanford. Care, J. G. White & Co., North Fork, Madera Co., Cal	Oct. 7, 1908
	Hewitt, Charles Edward. Trenton, N. J	Oct. 5, 1887
	Hickok, Henry Addison. Cons. and Const. Engr., Union Bldg., Newark, N. J	Oct. 7, 1896
	Hider, Arthur. U. S. Asst. Engr.; Res. Engr. in Local Chg. of Impvts., Lake Providence Reach, Mississippi River, Greenville, Miss	Sept. 7, 1881
	Higgins, George. Lecturer in Civ. Eng., Melbourne Univ., Melbourne, Victoria, Australia	Oct. 2, 1907
	Higgins, Horace Longuet. Pres. and Engr.-in-Chf., The Manila R. R. Co., Manila, Philippine Islands	May 2, 1906
	Hilgard, Karl Emil. Prof.; Cons. Civ. Engr., 18 Steinwiesstrasse, Zurich, V., Switzerland	June 4, 1890
	Hill, Albert Banks. Cons. Engr., 100 Crown St., New Haven, Conn. (*Jun., Feb. 2, 1876*)	Mar. 5, 1884
	Hill, Cicero Demerit. 1722 W. 101st St., Chicago, Ill	April 4, 1906
	Hill, Curtis. State Highway Engr., Columbia, Mo. (*Assoc. M., Oct. 2, 1901*)	Jan. 3, 1907
	Hill, Ernest Rowland, Pennsylvania Station, New York City	July 10, 1907
	Hill, George. Builder, 31 East 27th St., New York City. (*Assoc. M., Oct. 4, 1893*)	Feb. 1, 1899
	Hill, Henry Francis. 12 Allen Bldg., Augusta, Me	Mar. 6, 1907
	Hill, John Edward. Prof. of Civ. Eng., Brown Univ., Providence, R. I. (*Assoc. M., May 4, 1892*)	Mar. 31, 1908
	Hill, John Willmuth. 506 First National Bank Bldg., Cincinnati, Ohio. (*Jun., Feb. 3, 1875*)	April 5, 1876
	Hill, Louis Clarence. Phœnix, Ariz	Oct. 4, 1905
	Hill, Walter Hovey. Cons. Engr., Grangeville, Idaho	June 5, 1901
R.	Hill, William Ryan. Cons. Engr., 53 State St., Albany, N. Y	July 1, 1891
	Hilliard, Foster Haven. U. S. Asst. Engr.; Supt. of Dredging Operations with the Mississippi River Comm., Box 1017, Memphis, Tenn. (*Assoc. M., Mar. 6, 1901*)	May 1, 1906
	Hillyer, William Ross. Asst. Commr. of Public Works, Borough of Richmond, City of New York, Borough Hall, St. George (Res., Palmer Ave., Port Richmond), N. Y	May 6, 1903

	Date of Membership	
Himes, Albert James. Engr. of Grade Elimination, N. Y., C. & St. L. R. R. Co., Hickox Bldg., Cleveland, Ohio. (*Assoc. M., Nov. 6, 1895*)	June	7, 1899
Himmelwright, Abraham Lincoln Artman. Cons. and Superv. Engr., N. E. Cor. of 23d St. and 6th Ave., New York City	Oct.	5, 1898
Hinckley, Howard Vernon. Cons. Engr., 1018 North Harvey, Oklahoma City, Okla	Dec.	5, 1883
Hinckley, John Franklin. Cons. Engr., 1423 Syndicate Trust Bldg., St. Louis, Mo	May	6, 1885
Hinderlider, Michael Creed, 435 Century Bldg., Denver, Colo	Jan.	3, 1911
Hindes, Stetson George. Pres., San Francisco Bridge Co., 865 Monadnock Bldg., San Francisco, Cal	June	3, 1903
Hinds, Franklin Allen. Cons. Engr., 28 Flower Bldg., Watertown, N. Y.	May	3, 1899
Hiroi, Isami. Care, Coll. of Eng., Tokyo Imperial Univ., Tokyo, Japan	Dec.	1, 1908
Hitchcock, Frederick Collamore. Vice-Pres. and Gen. Mgr., MacArthur Bros. Co., 11 Pine St., New York City. (*Assoc. M., Mar. 7, 1894*)	Feb.	6, 1895
Hittell, John Benjamin. Chf. Engr. of Streets, Board of Local Impvts., 300 City Hall (Res., 5917 Winthrop Ave.), Chicago, Ill	July	1, 1909
Hoag, Sidney Willett, Jr. Deputy Chf. Engr., Dept. of Docks and Ferries, Pier A, North River, New York City	Sept.	2, 1885
Hobby, Arthur Stanley. Cons. Engr., Box 37, Guayaquil, Ecaudor. (*Assoc. M., Sept. 4, 1901*)	June	4, 1907
Hobson, Joseph. 346 Bay St. (South), Hamilton, Ont., Canada	Feb.	5, 1890
Hocke, Julius George. Secy. and Treas., General Contr. & Eng. Co., 29 Broadway, New York City (Res., 669 Ave. C, Bayonne, N. J.)	April	3, 1907
Hodgdon, Frank Wellington. Chf. Engr., Mass. Board, Harbor and Land Commrs., Room 131, State House, Boston, Mass	Dec.	3, 1884
Hodge, Harry Seymour. 83 Alfred St., Detroit, Mich	Oct.	3, 1894
Hodge, Henry Wilson. (Boller & Hodge, Cons. Engrs.), 149 Broadway, New York City. (*Jun., Jan. 5, 1887*)	Oct.	2, 1895
Hodges, Gilbert. Cons. Engr., Hill, N. H	June	4, 1890
Hodges, Harry Foote. Lt.-Col., Corps of Engr., U. S. A.; Member and Asst. Chf. Engr., Isthmian Canal Comm., Culebra, Canal Zone, Panama	Mar.	4, 1903
Hodgman, Harry. U. S. Asst. Engr., Detroit River Impvt., Amherstburg, Ont., Canada. (*Assoc. M., Mar. 2, 1904*)	May	31, 1910
Hoff, Olaf. Cons. Engr., 149 Broadway, New York City	May	6, 1885
Hoffman, Nathaniel Baker Klink. Asst. Engr., Bureau of Sewers, Borough of the Bronx, 2683 Creston Ave., New York City	Nov.	6, 1901
Hoffmann, Robert. Chf. Engr., Dept. of Public Service (Res., 1871 East 87th St.), Cleveland, Ohio. (*Assoc. M., June 5, 1901*)	Sept.	6, 1904
Hogeland, Albert Harrison. Chf. Engr., G. N. Ry., St. Paul, Minn	May	2, 1906
Hogg, James Breading. Civ. and Min. Engr., Connellsville, Pa	Oct.	3, 1906
Hohl, Leonhard John. Cons. Engr., 612 Marvin Bldg., San Francisco, Cal	Oct.	5, 1904
Holbrook, Elliot. Special Engr., U. P. System and S. P. Co., 135 Adams St., Chicago, Ill	Sept.	3, 1902
Holbrook, Frank Dudley. U. S. Asst. Engr., Wellsburg, W. Va. (*Assoc. M., Feb. 1, 1905*)	Jan.	7, 1908
Holbrook, Frederick William Doane. Navy Yard, Puget Sound, Bremerton, Kitsap Co., Wash	Oct.	6, 1886
Holbrook, John Byers. Cons. Engr., 3 South William St., New York City.	April	6, 1909
Holcombe, Joseph Gales. Chf. Engr. and Director of Public Works, Panama, Panama	May	4, 1904
Holden, Edward Henry. Asst. Engr., Topographical Bureau, Borough of the Bronx, 177th St. and 3d Ave. (Res., 1074 Boston Rd.), Bronx, New York City	May	6, 1908
Holgate, Henry. Cons. Engr. (Ross & Holgate), 80 St. François Xavier St., Montreal, Que., Canada	Oct.	2, 1901
Hollyday, Richard Carmichael. Civ. Engr., U. S. N.; Chf. of Bureau of Yards and Docks, Navy Dept., Washington, D. C	Sept.	2, 1903
Holman, Minard Lafever. Cons. Engr. (Holman & Laird), 3744 Finney Ave., St. Louis, Mo	April	2, 1884
Holmes, Glenn Dickinson. Chf. Engr., Intercepting Sewer Board, Room 317, City Hall, Syracuse, N. Y. (*Assoc. M., June 5, 1901*)	Mar.	5, 1907
Holmes, Howard Carleton. Cons. Engr.; Chf. Engr., San Francisco Dry Dock Co.; Chf. Engr., S. F., O. & S. J. Ry.; Cons. Engr., Docks and Wharfs, West. Pac. Ry., Room 804, Santa Marina Bldg., San Francisco, Cal	Nov.	4, 1903
Holmes, Lemuel. Engr. of Bridges, New York State Highway Comm., 12 South Hawk St., Albany, N. Y	Mar.	1, 1910
Holt, Arthur Grant. Div. Engr., C., M. & P. S. Ry., Spokane, Wash	April	5, 1910
Holt, Herbert Samuel. 297 Stanley St., Montreal, Que., Canada	Mar.	6, 1889
Holtzman, Stephen Ford. 11 East 24th St., New York City (Res., Hastings-on-Hudson, N. Y.). (*Assoc. M., Mar. 7, 1906*)	Nov.	1, 1910
Homberger, Heinrich. Cons. Engr., Room 864, Pacific Bldg., San Francisco, Cal	Oct.	5, 1909

	Date of Membership
Hone, Frederic de Peyster. (Frederic de P. Hone & Co.), 1 Liberty St., New York City. (*Jun., April 4, 1899; Assoc. M., Feb. 5, 1902*)	May 5, 1908
Honens, Frederick William. U. S. Asst. Engr., U. S. Engr. Office, Postal Telegraph Bldg. (Res., 3917 Belleview Ave.), Kansas City, Mo. (*Assoc. M., April 3, 1901*)	May 31, 1904
Hood, John Mifflin, Jr. Chf. Engr., United Rys. & Elec. Co., 1008 Continental Bldg., Baltimore, Md. (*Jun., May 31, 1904; Assoc. M., June 6, 1906*)	Sept. 6, 1910
Hood, Richard Haden. 541 Stelle Ave., Plainfield, N. J. (*Assoc. M., May 3, 1893*)	Nov. 2, 1898
Hood, William. Chf. Engr., S. P. Co., Room 1136, James Flood Bldg., San Francisco, Cal	Oct. 7, 1896
Hook, Gulian Schmalz. Civ. Engr., Gen. Elec. Co., Schenectady, N. Y.	April 3, 1901
Hoover, Herbert Clark. Red House, Hornton St., London, England	Jan. 4, 1910
Hoover, Joseph Warren. 537 New York Life Bldg., Kansas City, Mo.	June 6, 1888
Hopkins, Charles Comstock. (Knight & Hopkins, Hydr. and San. Engrs.), 349 Cutler Bldg., Rochester, N. Y.	June 4, 1890
Hopkins, Newton Fisher. With Harrop, Hopkins & Taylor, 900 Lewis Bldg., Pittsburg, Pa. (*Assoc. M., Oct. 2, 1907*)	Oct. 4, 1910
Hopkins, Stephen Upshur. Engr., 6th Div., Public Service Comm., 23 Flatbush Ave., Brooklyn, N. Y.	Oct. 5, 1909
Hopson, Ernest George. Superv. Engr., U. S. Reclamation Service, 501 Beck Bldg., Portland, Ore.	July 10, 1907
Horn, Frank Churchill. Const. Engr., Twin Falls Salmon River Land & Water Co., Twin Falls, Idaho	Sept. 1, 1903
Hornsby, Robert Wright. Casilla 73D, Santiago, Chili	Nov. 4, 1908
Horton, George Terry. Engr. and Mgr., Chicago Bridge & Iron Works, 105th and Throop Sts., Chicago, Ill.	April 6, 1904
Horton, Horace E. Prop., Chicago Bridge & Iron Works, Chicago, Ill.	Sept. 6, 1882
Horton, Robert Elmer. 57 North Pine Ave., Albany, N. Y. (*Assoc. M., Dec. 7, 1904*)	May 31, 1910
Horton, Theodore. Chf. Engr., New York State Dept. of Health, Albany, N. Y. (*Jun., Aug. 31, 1897; Assoc. M., April 4, 1900*)	June 6, 1905
Hotchkiss, Charles Wilcox. Gen. Mgr., Chic., Ind. & South. R. R., Indiana Harbor Belt R. R., 411 La Salle St. Station, Chicago, Ill.	Jan. 5, 1898
Hotchkiss, Louis Jenison. Asst. Bridge Engr., C., B. & Q. R. R., 209 Adams St., Chicago, Ill.	Nov. 30, 1909
Hough, David Leavitt. Pres., The United Eng. & Contr. Co. and The Cuban Eng. & Contr. Co., 17 West 42d St., New York City	May 5, 1897
Hough, Ulysses B. Engr. for Bunkerhill & Sullivan Min. & Concentrating Co., 616 Realty Bldg., Spokane, Wash.	Nov. 5, 1902
House, Francis Edwin. Pres., D. & I. R. R. R. Co., Duluth, Minn.	May 1, 1895
Houston, Gavin Nelson. Cons. and Superv. Engr., 518 Commonwealth Bldg., Denver, Colo. (*Jun., May 4, 1897; Assoc. M., Nov. 7, 1900*)	Feb. 2, 1909
Hovey, Otis Ellis. Asst. Chf. Engr., Am. Bridge Co. of N. Y., 30 Church St., New York City. (*Assoc. M., April 4, 1894*)	Jan. 3, 1900
How, Richard Willis. R. D. 3, Perry, N. Y. (*Jun. June 6, 1899; Assoc. M., Mar. 1, 1905*)	June 30, 1910
Howard, Charles Pope. 613 Osborn Bldg., Cleveland, Ohio. (*Assoc. M., Jan. 3, 1894*)	Oct. 31, 1905
Howard, Edward Henry. 71 Billings Rd., Quincy, Mass.	May 31, 1910
Howard, Frederick Billings. 30 Alexandrine Ave., E., Detroit, Mich. (*Jun., Mar. 3, 1875*)	Nov. 6, 1878
Howard, John Lewis. Res. Engr., City Hall, Pittsfield, Mass. (*Assoc. M., Dec. 7, 1898*)	April 2, 1902
Howe, Edward Willard. Asst. Engr., Eng. Dept., 65 City Hall, Boston, Mass.	Sept. 7, 1887
Howe, George Edward. Wauseon, Ohio. (*Assoc. M., Mar. 4, 1903*)	April 30, 1907
Howe, Joseph Milton. (Howe & Wise, Cons. Engrs.), 722 First National Bank Bldg., Houston, Tex. (*Assoc. M., Feb. 4, 1903*)	Jan. 7, 1908
Howe, Malverd Abijah. Prof., Civ. Eng., Rose Polytechnic Inst., 2108 North 10th St., Terre Haute, Ind. (*Assoc., May 7, 1890*)	Jan. 1, 1896
Howe, William Bell White. Spartanburg, S. C.	Mar. 1, 1893
Howell, David Janney. Union Trust Bldg., 15th and H Sts., N. W., Washington, D. C.	Sept. 5, 1900
Howell, Franklin Davinport. The Pacific Co., Civ. and Min. Engrs., 424 Central Bldg., Los Angeles, Cal.	June 5, 1901
Howell, George Pierce. Maj., Corps of Engrs., U. S. A., U. S. Engr. Office, Galveston, Tex.	Feb. 2, 1909
Howells, Julius Merriam. 135 Tunnel Rd., Berkeley, Cal.	June 4, 1902
Hoxie, Richard Leveridge. Brig.-Gen., U. S. A. (*Retired*), 1632 K St., N. W., Washington, D. C.	June 2, 1886
Hoyt, John Clayton. Asst. Chf. Hydrographer, U. S. Geological Survey, 1330 F St., N. W., Washington, D. C. (*Assoc. M., May 4, 1904*)	June 1, 1909
Hoyt, Warren Albert. Cons. and Contr. Engr., 455 Old Colony Bldg., Chicago, Ill.	June 30, 1910

	Date of Membership
Hoyt, William Edwin. Cons. Engr. and Special Engr., N. Y. C. & H. R. R. R. Co. (Res., 50 Westminster Rd.), Rochester, N. Y.	Mar. 5, 1884
Hubbard, Isaac Wendell. (Pugh & Hubbard), 601 Witherspoon Bldg., Philadelphia, Pa. (*Assoc. M., Mar. 1, 1905*)	Jan. 4, 1910
N. Hubbell, Clarence William. City Engr., Manila, Philippine Islands. (*Jun., May 31, 1898; Assoc. M., April 4, 1900*)	Jan. 5, 1904
Hudson, Clarence Walter. Prof. of Civ. Eng., Polytechnic Inst. of Brooklyn; Cons. Engr., 45 Broadway, New York City. (*Assoc. M., Nov. 7, 1894*)	Feb. 7, 1900
Hudson, John Rogers. 5353 Minerva Ave., St. Louis, Mo.	May 4, 1887
Huggins, William. Praca 13 de Maio No. 1, Sao Vicente, Santos, Brazil.	Feb. 7, 1906
Hughes, David Edward. U. S. Engr. Office, 723 Central Bldg., Los Angeles, Cal.	Sept. 6, 1905
Hughes, Hector James. Asst. Prof. of Civ. Eng., Harvard Univ., and Cons. Engr., 114 Pierce Hall, Cambridge, Mass.	May 3, 1905
Hughes, John Wilbur. Civ. Engr., Pennsylvania Gen. Elec. Co., 939 West 10th St., Erie, Pa.	June 30, 1910
Hughes, William Mackenzie. Cons. Bridge Engr., 532 Postal Telegraph Bldg., Chicago, Ill.	June 2, 1880
Humphrey, Richard Lewis. Cons. Engr., 805 Harrison Bldg., Philadelphia, Pa. (*Assoc. M., May 5, 1897*)	May 3, 1904
Humphreys, Alexander Crombie. Pres., Humphreys & Glasgow, Inc., Buffalo Gas Co., and Stevens Inst. of Tech., 165 Broadway, New York City.	Mar. 6, 1895
Humphreys, Clifton Stewart. Hydr. and Civ. Engr., I. O. O. F. Blk., Madison, Me. (*Assoc. M., May 2, 1900*)	April 5, 1910
Humphreys, David Carlisle. Dean and Prof. of Civ. Eng., Washington and Lee Univ., Lexington, Va.	Nov. 2, 1887
Hunt, Andrew Murray. Cons. Engr., Union Trust Bldg., San Francisco, Cal.	Feb. 7, 1906
HUNT, CHARLES WARREN. (*Secretary*). 220 West 57th St. (Res., 171 West 88th St.), New York City	Jan. 2, 1884
Hunt, Conway Bethune. Engr. of Highways, District of Columbia, District Bldg. (Res., 1815 M St., N. W.), Washington, D. C.	Feb. 4, 1891
Hunt, Robert Woolston. Robert W. Hunt & Co., 1121 The Rookery, Chicago, Ill.	June 3, 1885
Hunt, Rufus Cameron. Civ. Engr. and Contr., Washington Court House, Ohio.	Oct. 5, 1904
Hunter, John Burnap. Engr. and Member of Board of Public Works, 351 Broadway, Denver, Colo.	June 3, 1908
Hunter, Joseph Wray. State Highway Commr. of Pennsylvania, Jenkintown, Pa.	May 3, 1910
Hunter, William. Chf. Engr., P. & R. Ry., Room 520, Reading Terminal, Philadelphia, Pa.	June 5, 1895
Hunter, William Henry. 42 Spring Gardens, Manchester, England.	Feb. 7, 1906
Hurry, Edward Henry. Llanover, Churt, Farnham, England.	June 1, 1898
Huss, George Morehouse. Reserve, Wis.	May 1, 1907
Hussey, Ernest Bertrand. 1011 Alaska Bldg., Seattle, Wash.	July 1, 1908
Hutchings, William Evelyn. 1083 Cherokee Rd., Louisville, Ky.	June 7, 1899
Hutchins, Jere Chamberlain. Pres., Detroit United Ry., 12 Woodward Ave., Detroit, Mich. (*Assoc. M., Mar. 2, 1898*)	April 4, 1900
Hutchinson, Cary Talcott. Cons. Engr., 60 Wall St., New York City. (*Assoc. M., Mar. 4, 1896*)	Mar. 1, 1904
Hutchinson, George Hunt. Chf. Engr., North Western Fuel Co., Pioneer Press Bldg., St. Paul, Minn. (*Assoc. M., Sept. 2, 1891*)	June 7, 1893
Hyde, Abraham Lincoln. Asst. Prof. of Bridge Eng., Univ. of Missouri, Columbia, Mo. (*Assoc. M., April 5, 1893*)	Oct. 6, 1897
Hyde, Charles Gilman. San. and Hydr. Engr.; Prof. of San. Eng., Univ. of California, Civ. Eng. Bldg., Berkeley, Cal. (*Assoc. M., April 2, 1902*).	June 1, 1909

Ingalls, Owen Lovejoy. Asst. Engr., Engr. Dept. at Large, War Dept., Manila, Philippine Islands. (*Jun., Mar. 5, 1890*)	June 4, 1902
Ingersoll, Colin Macrae, Jr. Advisory Engr., 165 Broadway, Room 2127, New York City	June 5, 1895
Irwin, James Clark. Chf. Engr., Rutland R. R. Co., Rutland, Vt. (*Jun., April 4, 1893; Assoc. M., Dec. 7, 1898*)	June 6, 1900
Isaacs, John Dove. Cons. Engr., Harriman Lines, 135 Adams St., Chicago, Ill.	Mar. 7, 1894
Ives, Arthur Stanley. Asst. Gen. Mgr., Poughkeepsie Light, Heat & Power Co., Poughkeepsie, N. Y. (*Jun., Jan. 7, 1896; Assoc. M., Jan. 3, 1900*)	May 7, 1902

Jackson, Dugald Caleb. Prof. of Elec. Eng., Mass Inst. Tech.; Cons. Engr., Boston, Mass.	Nov. 2, 1898

	Date of Membership
Jackson, Thomas Herbert. Capt., Corps of Engrs., U. S. A., Room 405, Custom Bldg., San Francisco, Cal	Mar. 4, 1908
Jackson, Thomas Moore. Pres., West Va. Short Line R. R., Clarksburg, W. Va	June 3, 1891
Jackson, William Benjamin. (D. C. & Wm. B. Jackson, Cons. Engrs.), 508 Commercial National Bank Bldg., Chicago, Ill	Mar. 4, 1903
Jacob, Thomas Nottingham. Chf. Engr., East Side Levee and San. Dist., 205 Sexton Bldg., East St. Louis, Ill	May 4, 1909
Jacobs, Charles Mattathias. 30 Church St., New York City	May 4, 1904
Jacobs, Joseph. Cons. Engr., 406 Central Bldg., Seattle, Wash. (*Assoc. M., Sept. 4, 1901*)	April 6, 1909
Jacobsen, Hans Petter Rude. Cons. Engr., Randall's Blk., Oyster Bay, N. Y	May 3, 1910
Jacomb-Hood, John Wykeham. Chf. Engr., Lond. & S. W. Ry., Engr.'s Office, Waterloo Station, London, S. E., England	Feb. 5, 1902
James, William Atlee. Div. Engr. of Constr., Canadian Pacific Ry., 179 Cathedral Ave., Winnipeg, Man., Canada	July 1, 1909
Jameson, Charles Davis. Superv. Engr. and Archt. to the Imperial Chinese Board of Foreign Affairs (Wai Wu Pu), Peking, China	Mar. 7, 1888
Jamieson, James Alexander. Cons. and Designing Engr., Board of Trade Bldg., Montreal, Que., Canada	May 3, 1905
Jamieson, John Quintin. 475 Hassalo St., Portland, Ore	Nov. 6, 1889
Janes, George Portlock. 405 Third Ave., East, Roselle, N. J	May 1, 1907
Janney, William Dean. 2109 Homewood Ave., Baltimore, Md	April 1, 1896
Japp, Henry. S. Pearson & Son, Inc., 507 Fifth Ave., New York City	May 3, 1905
Jaques, William Henry. Civ. and Mech. Engr.; Pres., Hampton Water-Works Co., Little Boar's Head, N. H	July 2, 1890
Jarrett, Edwin Seton. The Foundation Co., 115 Broadway, New York City. (*Assoc. M., May 1, 1895*)	April 6, 1909
Jarvis, Charles Maples. Pres., Am. Hardware Corporation, New Britain, Conn	Jan. 7, 1885
Jaudon, Henry Scudder. Cons. Engr., Savannah Water-Works System, P. O. Box 582, Savannah, Ga. (*Assoc. M., Feb. 4, 1903*)	Feb. 1, 1910
Jaycox, Thomas William. Cons. Engr., Foster Bldg., Denver, Colo	Jan. 4, 1882
Jeme, Tien Yow. Chf. Director and Chf. Engr., Imperial Peking-Kalgan Ry., and Associate Director, Ichang-Wanhsien Sec., Szechuen Chuenhan Ry., Peking, China	Nov. 30, 1909
Jenckes, Lawrence Bates. 46 Fruit St., Worcester, Mass. (*Jun., Mar. 31, 1891; Assoc. M., Oct. 7, 1896*)	Sept. 6, 1910
Jenkins, William Dunbar. Engr. and Supt. of Constr. of Hamilton National Bank Bldg., Chattanooga, Tenn	Sept. 7, 1887
Jervey, Henry. Maj., Corps of Engrs., U. S. A., U. S. Engr. Office, Custom House, Cincinnati, Ohio	June 5, 1907
Jervey, James Postell. Maj., Corps of Engrs., U. S. A., Gatun, Canal Zone, Panama	Nov. 1, 1910
Jewel, Lindsey Louin. Gatun, Canal Zone, Panama. (*Assoc. M., April 4, 1906*)	Nov. 1, 1910
Jewett, William Cornell. Res. Engr., The Board of Hospital Commrs. (Res., 541 Ridgeway Ave.). Cincinnati. Ohio	June 3, 1885
Johnson, Albert Lincoln. 2d Vice-Pres., Corrugated Bar Co., St. Louis, Mo. (*Assoc. M., Sept. 2, 1896*)	Dec. 4, 1901
Johnson, Arthur Newhall. State Highway Engr., Springfield, Ill. (*Assoc. M., Sept. 2, 1903*)	July 1, 1909
Johnson, Chapman Love. Cons. Engr., 238 Mary St., Utica, N. Y	Oct. 7, 1903
Johnson, Francis Robert. Vernon, B. C., Canada	June 1, 1898
Johnson, James Moreland. Engr. and Pres., Louisville Bridge & Iron Co., Louisville. Ky	July 1, 1891
Johnson, Lewis Elisha. Asst. to Supt., B. and C. Dept., The Pennsylvania Steel Co., Steelton, Pa. (*Assoc. M., Nov. 4, 1896*)	May 1, 1901
Johnson, Lewis Jerome. Prof. of Civ. Eng., Harvard Univ., and Cons. Engr., 309 Pierce Hall, Cambridge, Mass. (*Assoc. M., Sept. 4, 1901*).	Nov. 1, 1904
Johnson, Lucien Samuel. U. S. Engr. Office, Frankfort, Ky	Dec. 4, 1901
Johnson, Phelps. Mgr., Dominion Bridge Co., Ltd., Windsor Hotel, Montreal, Que., Canada	July 1, 1891
Johnson, Thomas H. Cons. Engr., Penn. Lines W. of Pitts., Pittsburg, Pa.	Sept. 5, 1877
Johnson, William Stone. San. and Hydr. Engr., 101 Tremont St., Boston, Mass. (*Assoc. M., June 6, 1894*)	May 1, 1906
Johnston, Albert William. Gen. Mgr., The N. Y., C. & St. L. R. R., 424 Hickox Bldg., Cleveland, Ohio	Mar. 6, 1895
Johnston, Clarence Thomas. Prof. in Surveying, Eng. Dept., Univ. of Michigan, Ann Arbor, Mich	Sept 7, 1904
Johnston, Horace Greeley. Pres. and Gen. Mgr., The Am. Well & Prospecting Co., Corsicana, Tex	Sept. 7, 1887
Johnston, John Howard. Casapalca, Boulevard Cimiez, Nice, Alpes Maritimes, France	Mar. 1, 1876

	Date of Membership
Jonah, Frank Gilbert. Chf. Engr. of Constr., St. L. & San Fran. R. R. Co., Frisco Bldg., St. Louis, Mo.	Nov. 4, 1903
Jonas, Henry F. Prin. Asst. to Bridge Engr., Sunset Lines in Texas and Louisiana, P. O. Box 583, Houston, Tex.	Oct. 2, 1907
Jones, Arthur Lewis. Apartado No. 193, City of Mexico, D. F., Mexico	July 10, 1907
Jones, Howard Murfree. Cons. Engr., Room 407, Cole Bldg., Nashville, Tenn.	June 1, 1909
Jones, William Henry. Prin. Asst. Engr., Mo. Valley Bridge & Iron Co., 315 Vine St., Leavenworth, Kans.	May 4, 1904
Jordan, Edward Clarence. Civ. and Hydr. Engr., 31½ Exchange St., Portland, Me.	May 7, 1890
Jordán, Ricardo Tomás. Tech. and Commissary Insp., Tehuantepec National Ry., Rincón Antonio, Oax., Mexico	Oct. 4, 1910
Judd, Wilber Macaulay. (The W. G. Wilkins Co., Engrs. and Archts.), Westinghouse Bldg., Pittsburg, Pa.	Oct. 4, 1905
Judson, Charles Albert. Collector of Customs, Sandusky, Ohio	Jan. 3, 1894
Judson, William Pierson. Cons. Engr., Broadalbin, Fulton Co., N. Y.	Sept. 7, 1881
Judson, William Voorhees. Maj., Corps of Engrs., U. S. A., District Bldg., Washington, D. C.	Nov. 4, 1896
Juengst, Henry Frederick. Care, Am. Water-Works & Gas Co., P. O. Box 1103, Pittsburg, Pa.	April 2, 1884
Just, George Alexander. Cons. Engr.; Pres., The Geo. A. Just Co., 239 Vernon Ave., Long Island City, N. Y. (*Jun., Sept. 3, 1884*)	Mar. 4, 1891

Kadono, Chokuro. Engr. and Director, Okura & Co., Tokyo, Japan	Jan. 8, 1902
Kareischa, Serge de. Prof. of the Imperial Inst. of Engrs. of Ways and Communications; Asst. Gen. Mgr., Traffic Dept., Board of Direction, Russian Rys.; Pres., Assoc. of M. of W. Engrs., Russian Ry., Kasatchy pereoulok N 6, log. 6, St. Petersburg, Russia	June 6, 1894
Kastl, Alexander Edward. Special Deputy State Engr., Barge Canal Office, Albany, N. Y. (*Jun., Jan. 4, 1888*)	Nov. 5, 1890
Katté, Walter. The Ramondo, 784 Park Ave., New York City	Oct. 7, 1868
Kauffmann, William Frederick. Asst. Engr., N. Y. C. & H. R. R. R., 50 Lincoln Pl., East Rutherford, N. J.	Sept. 6, 1905
Kaufman, Gustave. Engr. and Mgr., The Wilson & Baillie Mfg. Co., 26 Court St., Brooklyn, N. Y.	May 7, 1890
Keating, Edward Henry. (Keating & Breithaupt, Cons. Engrs.), 82 King St., E., Toronto, Ont., Canada	June 7, 1882
Keefer, Charles Henry. 49 Metcalfe St., Ottawa, Ont., Canada	Oct. 7, 1908
KEEFER, THOMAS COLTRIN. (*Past-President*). Ottawa, Ont., Canada	April 4, 1877
Keith, George Thomas. Res. Engr., Impvt. of Public Highways, Olean, N. Y.	May 4, 1881
Keith, Herbert Cary. Cons. Engr., 116 Nassau St., New York City	Dec. 4, 1889
Keller, Charles. Maj., Corps of Engrs., U. S. A., U. S. Engr. Office, Rock Island, Ill.	Mar. 7, 1900
Keller, Charles Lincoln. First Asst. Engr., The Scherzer Rolling Lift Bridge Co., 1616 Monadnock Blk., Chicago, Ill. (*Jun., Oct. 4, 1898; Assoc. M., Mar. 6, 1901*)	Oct. 31, 1905
Kelley, Howard George. Chf. Engr., Grand Trunk Ry. System, Montreal, Que., Canada	May 1, 1889
Kelley, James Augustus. Andes, Delaware Co., N. Y. (*Assoc., Mar. 5, 1901; Assoc. M., Sept. 2, 1903*)	Mar. 3, 1908
Kelley, William Datus. Pres., Kelly & Kelley (Inc.), Engrs., Builders and Contrs.; Pres., Cowden & De Young, Inc., Elec. Contrs., 45 East 42d St., New York City	Nov. 2, 1887
Kellogg, Charles. Athens, Pa.	June 2, 1880
Kellogg, Norman Benjamin. Cons. Engr., Monadnock Bldg., San Francisco, Cal. (*Jun., Feb. 6, 1878*)	July 3, 1895
Kelly, Cassius William. City Engr., 17 City Hall, New Haven, Conn. (*Jun., Mar. 1, 1882*)	June 6, 1888
Kelsey, Louis Curtis. Cons. Engr., 402 Dooly Bldg., Salt Lake City, Utah.	Mar. 2, 1909
Kendall, Charles Hanford. Rushford, N. Y.	Nov. 6, 1907
Kendrick, John William. Vice-Pres., A., T. & S. F. Ry., Railway Exchange, Chicago, Ill.	June 6, 1883
Kendrick, Julian Way. First National Bank Bldg., Birmingham, Ala.	Oct. 1, 1902
Kenly, Edward Marion. Chf. Engr., Yakima Val. Transportation Co., P. O. Box Drawer O, North Yakima, Wash.	May 4, 1904
Kenly, William Lacy. Lake Montebello, Baltimore, Md.	Nov. 7, 1894
Kennedy, James Henry. Asst. Chf. Engr., Vancouver, Victoria & East. Ry. & Nav. Co., G. N. Ry. Depot, Vancouver, B. C., Canada	May 2, 1900
Kennedy, Jeremiah Joseph. Cons. Engr., 52 Broadway, New York City.	June 4, 1902
Kennedy, John. Cons. Engr., Harbor Commrs., 57 Common St., Montreal, Que., Canada	Sept. 1, 1875
Kennedy, William Harlin. 400 Atlantic Ave., Pittsburg, Pa.	Sept. 6, 1871

	Date of Membership
Kenney, Edward Fulbister. Metallurgical Engr., Cambria Steel Co., Johnstown, Pa. (*Jun., Nov. 3, 1896; Assoc. M., May 3, 1899*)	April 3, 1906
Kenrick, Robert Boteler. Care, Dominion Bridge Co., Montreal, Que., Canada	July 9, 1906
Kent, Willard. Narragansett Pier, R. I.	Oct. 2, 1907
Kernot, Maurice Edwin. Chf. Engr. for Ry. Constr., Victorian Rys., Ry. Dept., Spencer St., Melbourne, Victoria, Australia	June 5, 1907
Kerr, Frank Montgomery. Chf. State Engr. of Louisiana, New Orleans Court Bldg., New Orleans, La.	Oct. 2, 1901
Kerr, Halbert Stevens. Manti, Utah	Feb. 5, 1908
Kerr, Luther Yager. U. S. Engr. Office, Custom House, Memphis, Tenn.	June 4, 1902
Ketchum, Milo Smith. Dean, Coll. of Eng., and Prof. of Civ. Eng., Univ. of Colorado, Boulder, Colo. (*Assoc. M., Sept. 4, 1901*)	Mar. 3, 1908
Ketchum, Richard Bird. Assoc. Prof. of Civ. Eng., Univ. of Utah, Salt Lake City, Utah	June 5, 1907
Khuen, Richard. Res. Engr., Am. Bridge Co., Pittsburg, Pa. (*Jun., Dec. 3, 1891; Assoc. M., May 1, 1895*)	Nov. 2, 1898
Kibbe, Augustus Sayre. Chf. Engr., The Am. Rys. Co., 906 Witherspoon Bldg., Philadelphia, Pa. (*Jun., Mar. 6, 1889*)	Aug. 31, 1909
Kieffer, Stephen Ephraim. Cons. Engr., 805 Mechanics Inst. Bldg., San Francisco, Cal. (*Assoc. M., Oct. 5, 1904*)	Jan. 3, 1907
Kielland, Soren Theodor Munch Bull. Civ. Engr., Buffalo Creek R. R.; V. Consul of Norway, 364 Ellicott Sq., Buffalo, N. Y.	Feb. 6, 1889
Kiersted, Wynkoop. Cons. Engr., 58 Water-Works Bldg., Kansas City, Mo.	Oct. 5, 1887
Kimball, Frank Clifton. Civ. and Hydr. Engr., 14 Beacon St., Boston, Mass.	June 3, 1903
KIMBALL, GEORGE ALBERT. (*Director*). Chf. Engr., Elev. Subway Constr., Boston Elev. Ry., 101 Milk St., Boston, Mass. (*Jun., May 12, 1875*)	July 1, 1891
Kimball, George Henry. Cons. Engr., 1332 Penobscot Bldg., Detroit, Mich.	Dec. 3, 1890
Kimball, Herbert Sawyer. Mill Archt. and Chemical Engr., 46 Cornhill, Boston, Mass.	Nov. 1, 1910
Kimball, William Hale. 712 Putnam Bldg., Davenport, Iowa. (*Assoc. M. April 1, 1903*)	Jan. 31, 1911
King, Paul Sourin. Cons. Engr., 3034 North 15th St., Philadelphia, Pa.	July 3, 1889
King, William Byrd. Gen. Mgr., Fort Worth Stock Yards Co. and Fort Worth Belt Ry. Co., Fort Worth, Tex.	Oct. 7, 1896
King, Winfield Scott. 2311 G St., South Omaha, Nebr.	Dec. 6, 1899
Kingman, Lewis. Office Engr., National Rys. of Mexico, Buenavista (Res., 1-A Liverpool No. 3, City of Mexico), Mexico	July 1, 1885
Kingsley, Marvin Watson. Civ. and Hydr. Engr., 823 Rose Bldg., Cleveland, Ohio.	July 3, 1878
Kinnear, Wilson Sherman. Pres., Kansas City Terminal Ry. Co., 22d St. and Grand Ave., Kansas City, Mo.	July 9, 1906
Kinsley, Thomas Pearson. Supt., Bonticou Stone Co., New Paltz, N. Y.	Feb. 5, 1873
Kirkpatrick, Walter Gill. Cons. Municipal and Hydr. Engr., Jackson, Miss. (*Assoc. M., April 6, 1892*)	Oct. 5, 1898
Kittredge, George Watson. Chf. Engr., N. Y. C. & H. R. R. R., N. J. Shore Line R. R., Terminal Ry. of Buffalo, 335 Madison Ave., New York City	Jan. 6, 1886
Kittrell, James Wesson. Catskill, N. Y.	Sept. 1, 1897
Klapp, Eugene. Cons. Engr. (Wm. Barclay Parsons), 60 Wall St., New York City	Feb. 6, 1901
Kleinbeck, August Gustave. Litchfield, Ill.	Feb. 3, 1897
Klinck, John Henry. 123 N. Negley Ave., Pittsburg, Pa.	June 3, 1908
Kluegel, Charles Henry. Chf. Engr., Hilo R. R. Co., Hilo, Hawaii	Oct. 1, 1902
KNAP, JOSEPH MOSS. (*Treasurer*). 220 West 57th St., New York City	April 5, 1882
Knapp, Hermann Meriwether. Contr. Mgr., Am. Bridge Co. of N. Y., Union Trust Bldg., Cincinnati, Ohio. (*Assoc. M., May 6, 1903*)	Jan. 31, 1905
Knapp, Louis Henry. Civ. and Hydr. Engr., 280 Linwood Ave., Buffalo, N. Y.	Mar. 4, 1874
Knapp, Zac Ellis. Engr., Underground Elec. Rys. Co., Ltd.; Mgr., London United Tramways, Ltd., 74 High Rd., Cheswick, London, W., England	Dec. 5, 1906
Knickerbacker, John. Pres., Eddy Valve Co., Waterford, N. Y.	Jan. 2, 1900
Knickerbocker, Curtis Edwin. Engr., M. of W., N. Y., O. & W. Ry. Co., Middletown, N. Y.	Feb. 1, 1905
Knight, Charles William. Rome, N. Y.	July 9, 1906
Knight, Herbert Miller. Engr. for The M. A. Talbott Co. of Baltimore, Md.; Res., 205 West Garden St., Rome, N. Y.	May 3, 1910
Knight, Richard Warren. Contr. Engr., McClintic-Marshall Constr. Co., Park Bldg., Pittsburg, Pa.	Feb. 2, 1909
Knight, Walter Harris. Care, International Power Co., 165 Broadway, New York City	Feb. 1, 1893
Knighton, John Albert. Asst. Engr., Dept. of Bridges; Engr. in Chg., Queensboro Bridge, 305 East 60th St., New York City	Jan. 4, 1905

		Date of Membership
	Knobloch, Walstan Emile. U. S. Asst. Engr., 3338 St. Charles Ave., New Orleans, La	Oct. 2, 1907
	Knowles, Morris. Cons. Engr., 2548 Oliver Bldg., Pittsburg, Pa. *(Jun., Oct. 4, 1892; Assoc. M., Jan. 1, 1896)*	April 1, 1903
	Knowlton, Theodore Ely. Care, Church & Dwight Co., 63 Wall St., New York City. *(Assoc., Mar. 31, 1896; Assoc. M., May 7, 1902)*	Sept. 1, 1908
	Knox, Samuel Lippincott Griswold. Cons. Engr., Hammon Eng. Co., Alaska Commercial Bldg., San Francisco, Cal	July 10, 1907
	Knox, Schuyler Brush. Eastern Mgr. and Contr. Engr., Fort Pitt Bridge Works, 45 Broadway, New York City	Nov. 8, 1909
	Kondo, Sentaro. Doboku Shitchojo, Naimusho, Tokyo, Japan	Nov. 7, 1900
	Kondo, Toragoro. Chf. Engr., Home Dept., Tokyo, Japan. *(Jun., Oct. 3, 1888)*	June 5, 1901
	Kops, Julian de Bruyn. Civ. Engr. and Archt., 27 Bay St., East, Savannah, Ga. *(Assoc. M., April 4, 1894)*	Jan. 5, 1904
	Kower, Hermann. East Hall, Univ. of California, Berkeley, Cal	Oct. 5, 1904
	Kroeber, Adolf Thomas. Govt. Engr., Buiko, *via* Tanga, German East Africa	Oct. 2, 1907
	Kuersteiner, Emil Edward. Bridge Engr., L. & N. R. R., 1274 South Floyd St., Louisville, Ky	Dec. 1, 1897
	Kuichling, Emil. Cons. Engr., 52 Broadway, New York City	Sept. 3, 1884
C.	Kummer, Frederic Arnold. Cons. Engr., 26 South St., Baltimore, Md. *(Jun., April 30, 1895; Assoc. M., Mar. 4, 1903)*	Oct. 2, 1906
	Kunz, Frederic Charles. Cons. Engr., Osborne and Vicaris Sts., Wissahickon, Philadelphia, Pa. *(Assoc. M., Feb. 6, 1895)*	Dec. 7, 1898
	Kutz, Charles Willauer. Maj., Corps of Engrs., U. S. A., P. O. Box 1809, Seattle, Wash	May 7, 1902
	Kwong, King Yang. Engr.-in-Chf., Yueh-Han Ry., Canton, China	April 1, 1908

	Labelle, Henry Francis. Cons. Hydr. Engr., Silver City, N. M	April 6, 1898
	La Chicotte, Henry Arthur. Deputy Chf. Engr., Dept. of Bridges, City of New York, 21 Park Row, New York City	Oct. 3, 1894
	Lackey, Oscar Francis. Harbor Engr., Baltimore, Md. *(Assoc. M., May 4, 1904)*	April 6, 1909
	La Forge, Frederick William. U. S. Asst. Engr., Care, U. S. Engr. Office, New London, Conn	Oct. 5, 1904
	Lahmer, John Aloysius. Prin. Asst. Engr., The Kansas City Southern Ry. Co., Kansas City, Mo	June 3, 1908
	Lake, Edward Nelson. Stone & Webster Eng. Corporation, 147 Milk St., Boston, Mass	July 1, 1909
	Lall, Chiranji. Head Master, Govt. School of Eng., Nila Gumbad, Mool Chand St., Lahore, Punjab, India	Oct. 5, 1909
	Lamb, Richard. Cons. and Const. Engr., 136 Liberty St., Room 528, New York City. *(Assoc. M., May 6, 1891)*	June 6, 1900
	Landon, Eugene Ashbel. Secy. and Treas., Begent Lumber Co., Groton, N. Y	April 1, 1896
	Landor, Edward John. Contr. Engr., 1013 N. Walnut St., Canton, Ohio	Mar. 7, 1888
	Landreth, Olin Henry. Prof. of Eng., Union Coll.; Cons. Engr., Schenectady, N. Y	Sept. 3, 1884
	Landreth, William Barker. Cons. Engr., 20 Gillespie St., Schenectady, N. Y	Oct. 3, 1888
	Lane, Harry Alfred. Asst. to Chf. Engr., M. of W., B. & O. R. R., B. & O. Bldg., Baltimore, Md. *(Assoc. M., Feb. 1, 1905)*	Mar. 1, 1910
	Lang, Otto Heinrich. Archt. and Structural Engr. (Lang & Witchell), 622 Wilson Bldg., Dallas, Tex	Oct. 5, 1904
	Lange, Gunardo Anfin. Colonia Alvear, Prov. de Mendoza, Argentine Republic	Mar. 3, 1897
	Langthorn, Jacob Stinman. 122 St. James St., Kingston, N. Y	Jan. 4, 1905
	Langton, John. Cons. Engr., 31 Nassau St., New York City	May 2, 1900
	Lant, Frank Parsons. 135 Broadway, New York City. *(Jun., Oct. 3, 1888)*	Feb. 1, 1910
	Larrabee, William Dominick. Cons. Engr., 708 Grosse Bldg., Los Angeles, Cal	Oct. 5, 1904
	Larsson, Carl Gustaf Emil. Asst. Chf. Engr., Am. Bridge Co. of N. Y., 9 Rockview Terrace, Plainfield, N. J	April 1, 1903
	Latey, Harry Nelson. Cons. Engr., 100 Broadway, New York City	June 6, 1906
	Lathbury, Benjamin Brentnall. Pres., The Lathbury-D'Olier Co., Engrs., Morris Bldg., Philadelphia, Pa. *(Assoc. M., Mar. 3, 1897)*	June 6, 1905
	Latta, Harrison Wainwright. Pres., Latta & Terry Constr. Co., 1319 Pennsylvania Bldg., Philadelphia, Pa. *(Assoc. M., Sept. 5, 1900)*	April 4, 1905
	Laub, Hermann. 610 Lewis Blk., Pittsburg, Pa	Sept. 1, 1897
	Lavis, Fred. Cons. Engr. (Guerber, Lavis & Co.), 50 Church St., New York City. *(Assoc. M., Sept. 6, 1899)*	Sept. 4, 1906
	Lawlor, Francis Denis Hubert. Citizens Water Co., Burlington, Iowa. *(Jun., Oct. 6, 1886)*	Mar. 6, 1895

	Date of Membership
Lawrence, Edgar Heisler. Structural Engr., Nimmons & Fellows, Archts., 2007 Peoples Gas Bldg., Chicago, Ill.	Oct. 5, 1909
Lawson, Thomas R. William Howard Hart Prof. of Rational and Technical Mechanics, Rens. Poly. Inst., 99 Twelfth St., Troy, N. Y. (*Assoc. M., June 3, 1903*)	Jan. 3, 1907
Lawton, William Henry. City Engr., 24 Bellevue Ave., Newport, R. I.	June 2, 1886
Layfield, Elwood Norman. Div. Engr., B. & O. Chic, Terminal R. R., 353 Grand Central Passenger Station, Chicago, Ill.	June 5, 1907
Layton, Hudson Flack. Cons. Engr., Oliver Bldg., Pittsburg, Pa.	Nov. 30, 1909
Lea, Allan Benjamin. Araoz 2854, Palermo, Buenos Aires, Argentine Republic.	Mar. 4, 1908
Lea, Richard Smith. 405 Dorchester St., West, Montreal, Que., Canada.	July 1, 1908
Lea, Samuel Hill. State Engr. of South Dakota, State Capitol, Pierre, S. Dak.	Nov. 3, 1897
Lea, Sumter, Jr. 222 Seventy-third St., North, Birmingham, Ala.	Mar. 4, 1908
Leavenworth, George Stevens. Chf. Engr., Powers & Mansfield Co., 297 River St., Troy, N. Y. (*Assoc. M., June 3, 1903*)	Feb. 5, 1907
Leavitt, Charles Wellford, Jr. Civ. and Landscape Engr., 220 Broadway, New York City. (*Assoc. M., Jan. 4, 1898*)	May 2, 1905
Leavitt, Erasmus Darwin. 33 Garden St., Cambridge, Mass.	July 2, 1873
Leavitt, Frank McDowell. Cons. Engr. to E. W. Bliss Co., 133 Plymouth St., Brooklyn, N. Y.	Dec. 2, 1885
LeBaron, John Francis. Cons. Engr., Chardon, Ohio	June 7, 1882
LeConte, Louis Julian. U. S. Asst. Engr. in Chg. of Oakland Harbor Works, P. O. Box 482, Oakland, Cal.	April 4, 1877
Ledlie, Charles Hees. Cons. Engr., 918 Rialto Bldg., St. Louis, Mo.	Jan. 4, 1888
Ledoux, John Walter. Chf. Engr., The Am. Pipe Mfg. Co., 112 North Broad St., Philadelphia, Pa.	June 5, 1895
Lee, David Read. 12 Lake Ave., Middletown, N. Y. (*Assoc. M., Oct. 7, 1896*)	Nov. 1, 1910
Lee, Edward Hervey. Chf. Engr., Chic. & W. Indiana R. R. and The Belt Ry. of Chicago, Room 45, Dearborn Station, Chicago, Ill.	June 6, 1900
Lee, Francis Valentine Toldervy. Asst. Gen. Mgr. and Chairman, Eng. Committee, Pacific Gas & Elec. Co. and San Francisco Gas & Elec. Co., San Francisco, Cal.; Address, Care, Inst. of Elec. Engrs., Victoria Embankment, London, England	Feb. 1, 1910
Lee, Wellington Barnes. Hillburn, N. Y. (*Assoc. M., Feb. 5, 1896*)	May 4, 1898
Lee, William States. Chf. Engr., Southern Power Co., Charlotte, N. C.	Oct. 4, 1905
Leffingwell, Frank Dodge. 467 Bloomfield Ave., Montclair (Res., 716 Valley Rd., Upper Montclair), N. J. (*Assoc. M., Oct. 5, 1898*)	Dec. 5, 1905
Leffingwell, William Howland. Chf. Engr., Mono Power Co., Bishop, Inyo Co., Cal.	Oct. 4, 1893
Leffler, Burton Rutherford. Engr. of Bridges, L. S. & M. S. Ry., 1515 East 86th St., Cleveland, Ohio. (*Assoc. M., April 6, 1904*)	Sept. 6, 1910
Legaré, Balie Peyton. Engr., M. of W. and Constr., United Railroads of San Francisco, San Francisco, Cal.	July 10, 1907
Leh, Elwin Ulysses. Supt., Cowell Portland Cement Co.'s Plant, Cowell, Cal., *via* Bay Point	May 31, 1910
Lehlbach, Gustav. 196 Market St., Newark, N. J.	Mar. 7, 1883
Lehnartz, Frederick William. Siebengebirgs Allee 14, Klettenberg, Cologne, Germany	Aug. 6, 1879
Leighton, George. Res. Engr., D., L. & W. R. R. Co., Andover, N. J.	Oct. 3, 1906
Leisen, Theodore Alfred. Cons. Engr.; Chf. Engr. and Supt., Louisville Water Co., Louisville, Ky.	June 2, 1897
Leland, George Herbert. 930 Banigan Bldg., Providence, R. I. (*Jun., Mar. 2, 1887*)	Feb. 1, 1893
Leland, Ora Miner. Asst. Prof., Coll. of Civ. Eng., Cornell Univ., and Chf. of Party, Alaskan Boundary Comm., Cascadilla Bldg., Ithaca, N. Y. (*Assoc. M., Feb. 1, 1905*)	Mar. 1, 1910
Leland, Warren Allston. Chf. Engr. and Res. Mgr., Federal Constr. Co., Rockingham, N. C.	Oct. 3, 1900
Lentilhon, Eugene. Cons. Engr., 37 West 44th St., New York City. (*Jun., Mar. 1, 1891; Assoc. M., Mar. 6, 1895*)	Feb. 6, 1906
Leonard, Clifford Milton. Pres. and Treas., Canadian Leonard Constr. Co., Ltd.; Pres. and Treas., Leonard Constr. Co., 1937 McCormick Bldg., Chicago, Ill. (*Assoc. M., Oct. 2, 1907*)	May 31, 1910
Leonard, Henry Read. Engr. of Bridges and Bldgs., P. R. R. Co., Broad St. Station, Philadelphia, Pa.	April 4, 1894
Leonard, James Augustus. Asst. Engr., Ambursen Hydr. Cons. Co., 88 Pearl St., Boston, Mass.	April 1, 1908
Leonard, John Buck. Cons. Engr., Sheldon Bldg., San Francisco, Cal.	June 1, 1909
Lepper, Fred William. Supt. of Constr. of Public Bldgs., 504 Chamber of Commerce Bldg., Cleveland, Ohio. (*Assoc. M., Jan. 2, 1901*)	Feb. 6, 1906
Lewerenz, Alfred Courtney. Civ. Engr., U. S. N., Naval Station, Honolulu, Hawaii. (*Jun., Mar. 5, 1895; Assoc. M., June 6, 1900*)	Mar. 6, 1906
Lewinson, Maxymilian. 128 West 42d St., New York City	Feb. 7, 1894

		Date of Membership
	Lewis, Clarence Charles. Mgr., Cordoba Office, J. G. White & Co., Ltd., La Calera, Prov. de Cordoba, Argentine Republic	Feb. 6, 1907
	Lewis, Eugene Castner. Chairman, Board of Directors, N., C. & S. L. Ry.; Pres., The American Co., Nashville, Tenn	Mar. 5, 1873
	Lewis, Everett Wilson. Locating Engr., N. Y., N. H. & H. R. R., New Haven, Conn	Sept. 4, 1901
	Lewis, Frederick Humphreville. 732 Brown-Marx Bldg., Birmingham, Ala	Jan. 6, 1897
	Lewis, Marcus Winfield. U. S. Junior Engr., Care, Office, Chf. of Engrs., U. S. A., War Dept., Washington, D. C	June 5, 1907
	Lewis, Nelson Peter. Chf. Engr., Board of Estimate and Apportionment, 277 Broadway, New York City	Oct. 2, 1895
	Lewis, Sidney Francis. Chf. Engr., Orleans Levee Board, Suite 201, New Orleans Court Bldg., New Orleans, La	May 4, 1881
	Lewis, William Willett. Asst. Engr., Boston Transit Comm., 15 Beacon St., Boston, Mass	April 5, 1910
	Lieb, John William, Jr. Third Vice-Pres. and Assoc. Gen. Mgr., The New York Edison Co., 55 Duane St., New York City	Oct. 5, 1898
	Lilly, George Washington. Chf. Engr., St. Helens Public Service Co., 606 Marquam Bldg., Portland, Ore. (*Assoc. M., April 2, 1902*)	Jan. 31, 1905
R.	Lindenthal, Gustav. Cons. Engr., 45 Cedar St., New York City	May 3, 1882
	Lindsey, John Brown, Jr. Supt., West Pascagoula Creosoting Works, Gautier, Jackson Co., Miss. (*Assoc. M., June 3, 1903*)	Oct. 5, 1909
	Linton, Harvey. Cons. Engr., 1717 Thirteenth St., Altoona, Pa	Oct. 5, 1892
	Lippincott, Joseph Barlow. Asst. Chf. Engr., Los Angeles Aqueduct, 1108 Central Bldg., Los Angeles, Cal	Dec. 6, 1899
	Lipsey, Thomas Eugene Leard. Asst. Engr., Dept. of Constr. and Eng., Isthmian Canal Comm., Culebra, Canal Zone, Panama. (*Assoc. M., April 6, 1904*)	Oct. 2, 1906
	List, Charles. 302 Williams Bldg., San Francisco, Cal	June 3, 1903
	Livingston, Archibald Rogers. Supt., The Empire Zinc Co., Cañon City, Colo	April 3, 1907
	Llewellyn, Francis John. Div. Contr. Mgr., Am. Bridge Co. of N. Y., 1316 Commercial National Bank Bldg., Chicago, Ill	Nov. 4, 1896
	Llewellyn, Frederick Thomas. With Carnegie Steel Co., 30 Church St., New York City. (*Assoc. M., Oct. 4, 1899*)	May 1, 1906
	Locke, Charles Abbott. 1805 Belmont Circle, Nashville, Tenn	Oct. 3, 1888
	Locke, Franklin Buchanan. Commr. of Public Works, North Adams, Mass	Mar. 1, 1893
	Lockwood, James Button Clyde. Pres., Seattle Operating Co., East Sound, Wash	Mar. 6, 1901
	Lockwood, Judd Allen. Asst. Engr., Dept. of Bridges, 501 West 145th St., New York City	April 4, 1899
	Lockwood, Willard Datus. 23 Walnut Ave., Rockville Center, N. Y. (*Jun., April 3, 1894; Assoc. M., Oct. 7, 1896*)	Oct. 2, 1906
	Lockwood, William Frederick, Engr., M. of W., Interborough Rapid Transit Co., 165 Broadway, New York City	Oct. 4, 1910
	Loe, Eric Haldorson. Archt. and Engr., Russel Miller Milling Co., Minneapolis, Minn	Feb. 1, 1910
	Lofland, Henry Fiddeman. Gen. Mgr. of Erection, Am. Bridge Co. of N. Y., 15th and Chestnut Sts., Philadelphia, Pa	June 2, 1897
	Long, Maurice Alvin. Archt., B. & O. R. R., B. & O. R. R. Bldg., Baltimore, Md	Oct 5, 1909
	Look, Moses Jerome. Gen. Supt., MacArthur Bros. Co. and Winston & Co., Contrs., Brown Station, N. Y. (*Assoc. M., May 6, 1903*)	April 4, 1905
	LOOMIS, HORACE. (*Director*). Chf. Engr. of Sewers, Borough of Manhattan, 13 Park Row, New York City	Nov. 5, 1879
	Loomis, Thomas Hooker. Cons. and Contr. Engr., 62 Capitol Ave., Hartford, Conn	Jan. 7, 1903
	Loree, Leonor Fresnel. Care, Hoffman House, New York City	Oct. 6, 1886
	Lorraine, Madison Johnson. Willows, Glenn Co., Cal	Nov. 8, 1909
	Lovell, Frederick William. Secy., The McMyler Interstate Co. (Res., 10008 Lamont Ave.), Cleveland, Ohio	June 6, 1906
	Lovell, Walter Danville. Cons. Engr., 1415 Eighth St., S. E., Minneapolis, Minn	May 4, 1904
N.	Low, Emile. U. S. Asst. Engr., 540 Federal Bldg., Buffalo, N. Y	May 2, 1888
	Lowe, Jesse. (Christie & Lowe, Civ. Engrs. and Contrs.), 171 La Salle St., Chicago, Ill	Oct. 2, 1895
	LOWETH, CHARLES FREDERICK. (*Director*). Chf. Engr., C., M. & St. P. Ry., 1345, Railway Exchange, Chicago, Ill. (*Jun., Jan. 3, 1883*)	Feb. 6, 1884
	Lowrie, Harvey Childs. 1107 Flatiron Bldg., New York City	Mar. 2, 1892
	Lucas, Daniel Jones. Dept. of Public Works, Bureau of Surveys, Grade Crossing Div., Asst. Engr. in Chg. of Field Office, 2603 N. Broad St., Philadelphia, Pa. (*Jun., Sept. 6, 1876*)	July 4, 1888
	Lucas, Eugene Willett Van Court. Cons. Engr. with Herbert Lucas, Archt., 129 East 19th St., New York City. (*Assoc. M., April 3, 1895*)	Sept. 5, 1900

	Date of Membership
Lucius, Albert. 38 Park Row, Room 607, New York City	Mar. 3, 1886
Ludlow, Jacob Lott. Cons. Municipal, San. and Hydr. Engr., Winston-Salem, N. C	Mar. 3, 1897
Lueder, Archibald Byron. Engr., Merrill-Ruckgaber Co., New York City, 31 Ridgedale Ave., Morristown, N. J	May 31, 1910
Luiggi, Luigi. Insp. Gen., Royal Civ. Engrs.; Prof. of Maritime Constructions at the Royal School of Engrs., 81 Via Sardegna, Rome, Italy	Feb. 7, 1906
Lum, David Walker Chf. Engr., M. of W. and Structures, Southern Ry., Washington, D. C	May 3, 1893
Lundie, John. Cons. Engr., 52 Broadway, New York City	July 4, 1888
Lupfer, Alexander McClure. Chf. Engr., Spokane & Inland Empire R. R. Co., Terminal Bldg., Spokane, Wash	Nov. 1, 1905
Lupfer, Edward Payson. 590 Ellicott Sq., Buffalo, N. Y	Jan. 3, 1906
Luster, William Henry, Jr. City Surv., City Hall, Elizabeth, N. J. *(Assoc. M., Oct. 3, 1900)*	April 2, 1902
Lydon, William Anthony. Pres., Great Lakes Dredge & Dock Co., Chamber of Commerce, Chicago, Ill. *(Jun., Jan. 4, 1888)*	Dec. 5, 1894
Lyford, Oliver Smith, Jr. Cons. Engr., Westinghouse, Church, Kerr & Co., 10 Bridge St., New York City	May 6, 1908
Lynch, Michael Lehane. 425 Hamilton Ave., Jackson, Miss	May 4, 1892
Lyon, Henry Lloyd. Deputy Water Commr., Municipal Bldg., Buffalo, N. Y.	Feb. 3, 1904
Lyon, Léon Elie. Asst. U. S. Engr., U. S. Engr. Office, Norfolk, Va. *(Jun., Feb. 1, 1898 Assoc. M., April 4, 1900)*	June 5, 1906
Lyons, James Knox. Pres., Gas Power Eng. Corporation, Empire Bldg. (Res., 5820 Baum St., E. E.), Pittsburg, Pa. *(Assoc. M., May 1, 1895)*	Oct. 5, 1898

MacAllister, Dickinson. De Jonghe Hotel, Chicago, Ill	April 1, 1896
MacCalla, Clifford Sherron. Asst. Gen. Mgr., The Washington Water Power Co., Box 2158, Spokane, Wash	Mar. 1, 1910
MacDiarmid, Milo Stuart. Asst. Engr., U. S. Lake Survey, 205 Old Custom House, Detroit, Mich. *(Assoc. M., Sept. 4, 1907)*	April 5, 1910
MACDONALD, CHARLES. *(Past-President)*. 26 Exchange Pl., New York City	Sept. 15, 1869
MacGregor, Robert Athole. Asst. Engr., Bureau of Highways, Borough of the Bronx (Res., 2428 Lorillard Pl.), New York City. *(Assoc. M., Nov. 2, 1898)*	Mar. 1, 1910
Machen, Henry Bennett. Borough Engr., Dept., Water Supply, Gas and Electricity, 13 Park Row (Res., 315 West 97th St.), New York City. *(Jun., May 2, 1899; Assoc. M., Feb. 1, 1905)*	April 6, 1909
Mackall, Benjamin Franklin. 206 Met. Bank Bldg., Washington, D. C.	Mar. 6, 1901
MacKay, Henry Martyn. Prof. of Civ. Eng., McGill Univ., Montreal, Que., Canada	July 10, 1907
Mackenzie, Alexander. Retired Chf. of Engrs. and Maj.-Gen., U. S. A., The Birmingham, 2611 Adams Mill Rd., Washington, D. C. *(Hon. M., May 12, 1905)*	Feb. 2, 1887
Macksey, Henry Vincent. 15 Court Sq., Boston, Mass	May 4, 1904
N. Maclay, William Walter. Cons. Engr., Lee, Mass	Nov. 6, 1872
MacVicar, John Duncan. 1938 Howard Ave., North, Seattle, Wash	May 31, 1910
McCalla, William Augustus. City Engr., Decatur and New Decatur; Address, Decatur, Ala	Nov. 30, 1909
McCann, Thomas Henry. Chf. Engr., Hoboken Mfrs. R. R. Co., Second National Bank Bldg., Hoboken, N. J	April 2, 1890
McCarthy, George Arnold. Care, Smith, Kerry & Chace, Room 3, Bank B. N. A. Bldg., Calgary, Alta., Canada	Nov. 6, 1907
McCarty, Richard Justin. 3820 Warwick Boulevard, Kansas City, Mo.	Dec. 4, 1895
McCaustland, Elmer James. Prof. of Civ. Eng., Univ. of Washington; San. Engr., State Board of Health, 5264 Nineteenth Ave., N. E., Seattle, Wash. *(Assoc. M., Sept. 5, 1900)*	June 6, 1905
McClintock, J. Y. County Engr. of Monroe County, Rochester, N. Y	Oct. 2, 1895
McClintock, William Edward. Chairman, Board of Control, 27 Crescent Ave., Chelsea, Mass	Dec. 5, 1888
McClure, John Clarendon. Engr., M. of W., Arizona Eastern R. R., Tucson, Ariz. *(Assoc. M., Feb. 6, 1895)*	Jan. 3, 1911
McCollom, Thomas Chalmers. Civ. Engr., U. S. N. *(Retired)*, 4606 Springfield Ave., Philadelphia, Pa	May 3, 1882
McComb, Charles Oscar. Engr. and Contr., 403 University Bldg., Syracuse, N. Y	May 2, 1900
McComb, David E. Chf. Engr., Pavement and Sewerage Work, Havana, Cuba.	Feb. 7, 1877
McConaghy, Robert Allen. Care, Chinese Eng. & Min. Co., Chinwangtao, North China	Feb. 1, 1910
McConnel, Wilfred Gillette. Chf. Engr., Rio de Janeiro Tramway, Light & Power Co., Ltd., Rio de Janeiro, Brazil	June 3, 1903

	Date of Membership
McCool, Daniel. Pres., Newaygo (Mich.) Portland Cement Co. and Grand Rapids Edison Co., Grand Rapids, Mich.	Sept. 5, 1883
McCormack, Edgar Walter. San Ignacio 82, Havana, Cuba. (*Assoc. M., Mar. 6, 1901*)	Dec. 5, 1905
McCormick, George King. Roadmaster, L. & N. R. R. Co., Etowah, Tenn. (*Jun., Feb. 6, 1889*)	May 4, 1898
McCormick, Robert Hugh. City Engr., Detroit, Mich.	Sept. 7, 1898
McCoy, Samuel Alexander. Contr. (Boynton, Church & McCoy), 1725 Eleventh Ave., Spokane, Wash. (*Assoc. M., Sept. 6, 1905*)	Dec. 4, 1906
McCrickett, Thomas Francis. Care, Russel Wheel & Foundry Co., Detroit, Mich.	Jan. 2, 1907
McCulloch, Robert Austen. Chf. Engr., with Raymond F. Almirall, Archt., 185 Madison Ave., New York City. (*Jun., Sept. 2, 1902; Assoc. M., Sept. 7, 1904*)	Sept. 3, 1907
McCulloh, Ernest. Project Engr., U. S. Reclamation Service, Sunnyside, Wash.	May 6, 1903
McCulloh, Walter. Cons. Engr., N. Y. State Water Supply Comm., Lyon Blk., Albany, N. Y. (*Jun., July 4, 1888*)	June 7, 1893
McCullough, Ernest. Cons. Engr., 2114 Fisher Bldg., Chicago, Ill.	May 31, 1910
McDaniel, Allen Boyer. Prof. of Civ. Eng., Univ. of South Dakota; Cons. Engr. and Archt., Vermilion, S. Dak. (*Assoc. M., Nov. 1, 1905*)	Dec. 6, 1910
McDONALD, HUNTER. (*Vice-President*). Chf. Engr., N. C. & St. L. Ry., 10 Terminal Station, Nashville, Tenn. (*Jun., April 4, 1883*)	Mar. 7, 1888
McDonald, John Alexander. Care, James E. McDonald, 4 Chapel St., Cripplegate, London, E. C., England	Feb. 5, 1890
McDonald, William Naylor. Gen. Contr., 781 East Bay St., Jacksonville, Fla.	Sept. 3, 1902
McDonnell, Robert Emmett. Civ., Hydr. and San. Engr., Room 804, Scarritt Bldg., Kansas City, Mo.	Oct. 5, 1909
McDonough, James Albert. Junior Engr., U. S. Engr. Office, P. O. Box 75, Wheeling, W. Va. (*Assoc. M., April 3, 1907*)	May 3, 1910
McElroy, Fred Woodburn. With Bellew & Merritt Co., 226 Niagara St., Lockport, N. Y.	Sept. 6, 1910
McFarland, Walter Ashfield. Supt., Water Dept., Washington, D. C.	May 3, 1910
McFetridge, William Sutton. Plum St., Greenville, Pa. (*Jun., May 3, 1898; Assoc. M., Mar. 4, 1903*)	Sept. 3, 1907
McGilvray, Thomas Forrester. Cons. Engr.; City Engr., City Hall, Duluth, Minn. (*Assoc. M., Feb. 5, 1902*)	June 6, 1905
McGrath, Wallace. 910 Tennessee St., Lawrence, Kans.	Sept. 5, 1883
McGrew, Anson Burlingame. U. S. Asst. Engr., Room 2106, Farmers Bank Bldg., Pittsburg, Pa.	June 4, 1902
McHenry, Edwin Harrison. Vice-Pres., N. Y., N. H. & H. R. R., New Haven, Conn.	Feb. 5, 1896
McInnes, Frank Alexander. Asst. City Engr., City of Boston, 23 Salcombe St., Dorchester, Mass.	Jan. 8, 1908
McKay, George Albert. Civ. Engr., U. S. N., Mare Island, Cal. (*Assoc. M., Feb. 4, 1903*)	Nov. 8, 1909
McKay, Hood. Min. Engr., Care, George G. Hood, Mt. Airy, Philadelphia, Pa.	Nov. 6, 1907
McKeen, Benjamin. Gen. Mgr., Vandalia R. R., 806 Century Bldg., St. Louis, Mo.	Nov. 6, 1895
McKenney, Charles Albert. Cons. Engr., Hibbs Bldg., Washington, D. C. (*Jun., Dec. 4, 1894; Assoc. M., Dec. 1, 1897*)	Mar. 2, 1909
McKenzie, Theodore Hall. Engr., State Board of Health; Member, State Board of Civ. Engrs., State Capitol, Hartford (Res., Southington), Conn.	Sept. 7, 1881
McKibben, Frank Pape. Prof. of Civ. Eng., Lehigh Univ., South Bethlehem, Pa. (*Jun., Jan. 3, 1895; Assoc. M., Mar. 6, 1901*)	Oct. 3, 1905
McKim, Alexander Rice. Cons. Engr., 116 East 28th St., New York City. (*Assoc. M., April 4, 1894*)	May 4, 1898
McKim, James Arthur. Secy.-Treas., Westlake Const. Co., Mercantile Bldg., St. Louis, Mo.	Oct. 2, 1901
McKinstry, Charles Hedges. Maj., Corps of Engrs., U. S. A., P. O. Box 155, Manila, Philippine Islands. (*Assoc. M., Sept. 2, 1896*)	May 3, 1899
McLain, Louis Randolph. Pres., Florida Eng. Co., St. Augustine, Fla.	Feb. 2, 1881
McLean, Archibald. Asst. Engr., Dept. of Bridges, City of New York, 179 Washington St., Brooklyn, N. Y.	May 6, 1903
McLoud, Paul. Div. Engr., State Dept. of Highways, Binghamton, N. Y.	Sept. 6, 1910
McMath, Robert Emmet. Pres., R. E. McMath Surveying Co., 328 Lincoln Trust Bldg., St. Louis, Mo.	Mar. 3, 1880
McMillan, Charles. Prof. of Civ. Eng., Princeton Univ.; Cons. Engr., Princeton, N. J.	Jan. 29, 1868
McMillan, John Gilmore. County Surv., Santa Clara Co., Hall of Records, San José, Cal.	Oct. 5, 1909
McMinn, Thomas James. (*Assistant Secretary*). 220 West 57th St., New York City (Res., 622 Ave. K, Flatbush, Brooklyn, N. Y.)	Mar. 5, 1890
McMorris, Daniel Webster. Prin. Asst. City Engr., Seattle, Wash.	May 2, 1906

	Date of Membership
McMurtry, Guy. Yuba City, Cal	Mar. 2, 1909
McNab, William. Prin. Asst. Engr., Grand Trunk Ry. System, Montreal, Que., Canada	Dec. 1, 1908
McNaugher, David White. (Robert W. Hunt & Co.), Monongahela Bank Bldg., Pittsburg, Pa	June 3, 1908
McNeal, John. City Engr. and Supt. of Streets, Columbia, S. C	Dec. 2, 1903
McNicol, John Alexander. Box 733, Havana, Cuba	Sept. 1, 1897
McNulty, George Washington. 139 West 79th St., New York City	May 5, 1880
McReynolds, Orval Omar. Cons. Civ. and Min. Engr., Maricopa, Kern Co., Cal. (*Assoc. M., Dec. 5, 1900*)	Mar. 5, 1907
Main, Charles Thomas. 201 Devonshire St., Boston, Mass	July 1, 1909
Mais, Henry Coathupe. 34 Murphy St., South Yarra, Melbourne, Victoria, Australia	June 6, 1883
Maitland, Alexander, Jr. 4104 Harrison St., Kansas City, Mo	Nov. 6, 1901
Malmros, Nils Lorentz. Care, Ernest Flagg, 35 Wall St., New York City.	Feb. 1, 1910
Maloney, James Edward. Supt., River Div., Denver Union Water Co., Littleton, Colo	Oct. 7, 1908
Maltby, Frank Bierce. 109½ Lexington Ave., Syracuse, N. Y	April 3, 1895
Man, Albon Platt. Richmond Hill, N. Y	Sept. 5, 1883
Manahan, Elmer Gove. Member, Firm of Hering & Fuller, 170 Broadway, New York City. (*Assoc. M., Oct. 7, 1903*)	Feb. 2, 1909
Manchester, Ernest James Theodore. Pres., Water Supply and Sewerage Board, Brisbane, Australia. (*Assoc. M., May 3, 1905*)	Oct. 4, 1910
Manley, Henry. Asst. Engr., Eng. Dept., Boston, 116 Mt. Vernon St., West Roxbury, Mass	June 2, 1880
Manley, Laurence Bradford. Asst. Engr., Boston Transit Comm., 15 Beacon St., Boston, Mass	July 1, 1909
Mann, John Laroy. Ingeniero del Gobierno, Dept. of Public Works, Santo Domingo, Santo Domingo. (*Jun., April 2, 1901; Assoc., May 6, 1902; Assoc. M., Sept. 1, 1908*)	Jan. 3, 1911
Manning, Rollo Glenroy. Engr., Ambridge Plant, Am. Bridge Co., Ambridge, Pa. (*Assoc. M., Oct. 2, 1901*)	Oct. 30, 1906
Manson, Marsden. City Engr., 2010 Gough St., San Francisco, Cal	Sept. 6, 1882
Marburg, Edgar. Prof. of Civ. Eng., Univ. of Pennsylvania, Philadelphia, Pa	Oct. 6, 1897
Marden, Walter Reuben. Vice-Pres. and Chf. Engr., The United Constr. Co., 467 Broadway, Albany, N. Y. (*Assoc. M., April 4, 1894*)	Feb. 28, 1905
Marple, William McKelvey. Chf. Engr., The Scranton Gas & Water Co., Dunmore Gas & Water Co., Olyphant Water Co., Archbald Water Co. and Consolidated Water Supply Co., Scranton, Pa	June 4, 1890
Marr, William Walter. 1240 Cornelia Ave., Chicago, Ill	Feb. 2, 1909
Marroquin y Rivera, Manuel. 3ª Calle Manuel Mª Contreras No. 38, City of Mexico, D. F., Mexico	June 5, 1907
Marsh, Charles Fleming. Chf. Asst. Engr., Met. Water Board, Savoy Court, London, England	Oct. 3, 1906
Marsh, James Barney. Pres. and Chf. Engr., The Marsh Bridge Co., Des Moines, Iowa	May 3, 1905
Marshall, Horace Miller. U. S. Asst. Engr., Vicksburg, Miss	Dec. 3, 1890
Marshall, Robert Albertsen. Structural Engr., Westinghouse, Church, Kerr & Co., 10 Bridge St., New York City	April 1, 1908
Marshall, Robert Bradford. Chf. Geographer, U. S. Geological Survey, Washington, D. C	May 4, 1904
Marston, Anson. Dean of Div. of Eng., Iowa State Coll.; Cons. Engr., Ames, Iowa. (*Assoc. M., Oct. 4, 1893*)	Oct. 7, 1903
Marstrand, Otto Julius. 5 Lloyds Ave., London, E. C., England	May 7, 1890
Martin, Edgar Darwin. 172 Washington St., Chicago, Ill	July 1, 1909
Martin, James William. Supt. of Irrig., U. S. Indian Service, Toppenish, Wash. (*Assoc. M., Nov. 1, 1899*)	April 5, 1910
Martin, Kingsley Leverich. Commr. of Bridges, City of New York, Park Row Bldg., New York City. (*Jun., Nov. 5, 1895; Assoc. M., May 3, 1899*)	Dec. 1, 1903
Martin, William. 400 Dawson Ave., Bellevue, Pa	Jan. 7, 1903
Martin, Wisner. 50 Highland Ave., Station A, Cambridge, Mass. (*Jun., May 3, 1892; Assoc. M., July 3, 1895*)	May 1, 1901
Marvin, Frank Olin. Dean and Prof. of Civ. Eng., School of Eng., Univ. of Kansas, Lawrence, Kans	May 5, 1897
Marx, Charles David. Prof. of Civ. Eng., Leland Stanford, Jr., Univ.; Cons. Engr., Stanford University, Santa Clara Co., Cal	Oct. 7, 1896
Mason, Arthur John. (Hoover & Mason), Railway Exchange, Chicago, Ill.	Sept. 5, 1888
Mason, Francis. (Mason, Hilton & Co., Engrs. and Contrs.), 17 Battery Pl., New York City. (*Jun., April 3, 1900; Assoc. M., April 1, 1903*).	July 1, 1909
Mason, George Cotner. Engr. and Contr., Board of Trade Bldg., Portland, Ore. (*Jun., Mar. 6, 1894; Assoc. M., May 3, 1899*)	Sept. 1, 1908
Mason, Sampson Douglas. Asst. Engr., U. S. Fortification Work, Fort Casey, Wash	Oct. 6, 1886
Mason, William Pitt. Prof. of Chemistry, Rensselaer Polytechnic Inst., and Water Specialist, Troy, N. Y	Feb. 1, 1910

	Date of Membership
Matamoros, Luis. Gen. Director of Public Works of Costa Rica; Chf. Engr. of Constr., Costa Rica Pacific Ry., P. O. Box 295, San José, Costa Rica	Oct. 4, 1905
Matcham, Charles Arthur. Cons. Engr., 1727 Hamilton St., Allentown, Pa.	June 5, 1901
Mather, Thomas Hoggan. Chf. Engr., Syracuse R. R. Constr. Co., Onondaga County Savings Bank Bldg., Syracuse, N. Y.	Oct. 1, 1902
Mathewson, Isaac. Hacendado, Santa Fé, Guerrero, Mexico. (*Assoc. M., Mar. 7, 1894*)	Mar. 1, 1904
Mathewson, Thomas Knight. Chf. Engr., Michoacán Power Co., Villaseñor, Guanajuato, Mexico	May 1, 1907
Matthes, Gerard Hendrik. Hydr. Engr., The Central Colorado Power Co., Denver, Colo. (*Assoc. M., June 6, 1900*)	Jan. 31, 1905
Maurice, Charles Stewart. Athens, Pa.	May 15, 1872
Maurice, George Holbrooke. Prin. Asst. Engr., Board of Public Works, 27 South 2d St., Harrisburg, Pa.	Jan. 4, 1910
Maury, Dabney Herndon. Cons. Engr., 129 North Jefferson Ave., Peoria, Ill.	May 3, 1899
Maxim, *Sir* Hiram Stevens. Ryecotes, Dulwich Common, London, S. E., England	Oct. 7, 1885
Maximoff, Sergius Pavlovitch. Engr. to the Imperial Russian Govt.; Asst. at the Imperial Inst. of Public Ways at St. Petersburg, Zabalkanski pr. 21, St. Petersburg, Russia. (*Assoc. M., April 1, 1903*)	Sept. 1, 1908
Maxson, Frank Oscar. Civ. Engr., U. S. N., U. S. Naval Station, Box 337, Key West, Fla.	May 1, 1889
Maxwell, James Riddle. Cons. Engr., Newark, Del.	April 17, 1872
May, DeCourcy. Pres., New York Shipbuilding Co., Camden, N. J.	Mar. 6, 1895
May, William Andrew. Gen. Mgr., Hillside Coal & Iron Co., Box 553 Scranton, Pa.	July 6, 1881
Mayer, Joseph. Prin. Asst. Engr., Quebec Bridge Comm., Canadian Express Bldg., Montreal, Que., Canada	Oct. 3, 1894
Mead, Charles Adriance. Engr. of Bridges, Board of Public Utility Commrs., State of New Jersey, Trenton (Res., 165 Wildwood Ave., Upper Montclair), N. J. (*Assoc. M., April 5, 1899*)	Jan. 5, 1904
Mead, Daniel Webster. Prof., Hydr. and San. Eng., Univ. of Wisconsin; Cons. Engr., 530 State St., Madison, Wis. (*Assoc. M., July 1, 1891*)	Dec. 6, 1893
Mead, Elwood. Chairman, State Rivers and Water Supply Comm.; Chf. Engr., Water Supply Dept., Melbourne, Victoria, Australia	June 7, 1893
Meads, Charles. Pres., Charles Meads & Co., 299 Broadway, New York City.	Sept. 6, 1910
Means, Thomas Herbert. (Symmes & Means), 515 Mechanics Inst. Bldg., San Francisco, Cal. (*Assoc. M., July 10, 1907*)	Oct. 5, 1909
Mebus, Charles Fillmore. Civ. and San. Engr., 908 Land Title Bldg., Philadelphia, Pa.	May 2, 1906
Meem, James Cowan. Engr. for Frederick L. Cranford, 190 Montague St., Brooklyn, N. Y. (*Assoc. M., April 1, 1896*)	April 4, 1905
Meem, Stephen Halsey. Civ. and Min. Engr. (Meem & Haskins), Bluefield, W. Va.	Feb. 1, 1910
Mees, Curtis Adolph. Designing Engr., Southern Power Co., Charlotte, N. C. (*Assoc. M., Sept. 6, 1905*)	Nov. 2, 1908
Meigs, Montgomery. U. S. Civ. Engr., U. S. Engr. Office, Keokuk, Iowa	Mar. 5, 1879
Melcher, Frank Otis. Gen. Mgr., C., R. I. & P. Ry., La Salle St. Station, Chicago, Ill.	Mar. 3, 1897
Melliss, David Ernest. Cons. Civ. and Min. Engr., 802 Fifth Ave., San Rafael, Cal.	Oct. 2, 1895
Melvin, David Neilson. Supt. and Engr., Am. Linoleum Mfg. Co., Linoleumville, N. Y.	July 3, 1878
Menden, William Stephen. Asst. Gen. Mgr., Brooklyn Rapid Transit System, 85 Clinton St., Brooklyn, N. Y.	April 4, 1906
Mendiola, Manuel Maria. Chf. Engr., Rio Grande Impvt. Works, Mexican Govt., Ciudad Juàrez, Chihuahua, Mexico	Dec. 5, 1906
Mensch, Leopold Jehud. Gen. Contr., 70 La Salle St., Chicago, Ill.	Oct. 4, 1905
Mercer, Charles Hatton. Chf. Engr., Bridge and Constr. Dept., The Pennsylvania Steel Co., Steelton, Pa. (*Assoc. M., Nov. 3, 1897*)	May 1, 1901
Meredith, Wynn. 907 Union Trust Bldg., San Francisco, Cal.	June 1, 1909
Merrill, George Nathan. Cons. Engr. (Merrill & Sears), 274 Main St., Springfield, Mass.	May 1, 1889
Merrill, William Fessenden. 830 Carlton Ave., Plainfield, N. J.	April 1, 1874
Merriman, Mansfield. Cons. Engr., 32 West 40th St., New York City. (*Jun., May 12, 1875*)	Sept. 3, 1884
Merriman, Thaddeus. Dept. Engr.; Asst. to Chf. Engr., Board of Water Supply of the City of New York, 165 Broadway, New York City. (*Jun., April 4, 1899; Assoc. M., April 1, 1908*)	Dec. 6, 1910
Merritt, David Spencer. 104 Grove St., Tarrytown, N. Y.	Jan. 4, 1905
Merryman, William Curtis. Res. Engr., Rapid Transit Subway Constr. Co., 165 Broadway (Res., 537 West 149th St.), New York City	Oct. 4, 1899
Mersereau, Charles Vernon. 1324 Chemical Bldg., St. Louis, Mo.	Dec. 3, 1884
Mershon, Ralph Davenport. Cons. Engr., 60 Wall St. (Res., 65 West 54th St.), New York City	April 3, 1907

	Date of Membership
Meryweather, Henry Francis. Chf. Asst. Engr., Board of Public Works, 1276 Corona St., Denver, Colo.	April 1, 1908
Metcalf, Leonard. (Metcalf & Eddy, Cons. Engrs.), 14 Beacon St., Boston, Mass. (*Assoc. M., Jan. 5, 1898*)	Sept. 2, 1903
Meyer, Rudolf. Inspecting Engr., Water-Works and Sewerage System, Monterey, Mexico	Oct. 5, 1898
Middlebrook, Charles Trinder. Cons. Engr., 82 State St., Albany, N. Y.	Nov. 30, 1909
Miles, John Wiley. Locating Engr., Ferrocarriles Nacionales de Mexico, Aldama, Tamaulipas, Mexico. (*Assoc. M., Oct. 2, 1901*)	April 6, 1909
Millard, Charles Sterling. Engr., Track and Roadway, C., C., C. & St. L. Ry., Cincinnati, Ohio. (*Jun., May 2, 1899; Assoc. M., June 5, 1901*).	Jan. 31, 1905
Miller, Charles Henry. Engr., River Protection, Mo. Pac. Ry. Co., Title Guarantee Bldg., St. Louis, Mo.	May 2, 1899
Miller, Edward Furber. Prof. of Steam Eng., Mass. Inst. Tech., Boston (Res., 538 Ward St., Newton Center), Mass.	June 3, 1903
Miller, Frank. (Long & Miller, Cons. Engrs.), 220 Broadway, New York City	Oct. 5, 1904
Miller, Harvey Cooper. Contr. Engr., 1 Madison Ave., New York City	June 5, 1901
Miller, Hiram Allen. Cons. Engr., Metropolitan Park Comm., 14 Beacon St., Room 507, Boston (Res., 15 Duncklee St., Newton Highlands), Mass.	May 6, 1896
Miller, Rudolph Philip. Supt. of Bldgs., Borough of Manhattan, 220 Fourth Ave., New York City. (*Jun., Jan. 2, 1890; Assoc. M., April 7, 1897*)	Jan. 5, 1904
Miller, Spencer. Chf. Engr., Cableway Dept., Lidgerwood Mfg. Co., 96 Liberty St., New York City. (*Assoc. July 3, 1889*)	Nov. 7, 1894
Millis, John. Col., Corps of Engrs., U. S. A., Federal Bldg., Cleveland, Ohio	Mar. 7, 1900
Mills, Arthur Lorenzo. Pres., Peat Industry Co., Apartado 123 Bis, City of Mexico, Mexico	May 2, 1888
Mills, Charles Malon. Cons. Engr., The E. E. Smith Contr. Co., 71 Broadway, Room 415, New York City. (*Jun., June 2, 1886*)	Sept. 3, 1890
Miner, Charles Augustine. 530 Bond Bldg., Washington, D. C. (*Assoc. M., April 7, 1897*)	Dec. 4, 1901
Miner, Edward Fuller. Pres., Central Bldg. Co., Worcester, Mass.	June 3, 1908
Minor, Edward Eastman. Supt., New Haven Water Co., 493 Edgewood Ave., New Haven, Conn. (*Jun., May 1, 1900*)	Mar. 4, 1908
Mitchell, Charles Hamilton. Cons. Engr. (C. H. & P. H. Mitchell), Traders Bank Bldg., Toronto, Ont., Canada. (*Assoc. M., June 4, 1902*).	Jan. 5, 1904
Mitchell, Samuel Phillips. Pres., Seaboard Constr. Co. and Am. Equipment Co., 1024 Witherspoon Bldg., Philadelphia, Pa.	April 1, 1903
Mitchell, William Selby. U. S. Engr. Office, Custom House, St. Louis, Mo.	June 1, 1909
Mixer, Charles Adam. Engr., Rumford Falls Power Co., Rumford, Me.	Nov. 1, 1893
Moberly, Frank. Barrie, Ont., Canada	Oct. 7, 1903
Modjeski, Ralph. Cons. Engr., 1750 Monadnock Bldg., Chicago, Ill. (*Jun., Dec. 1, 1886; Assoc. M., July 1, 1891*)	Mar. 3, 1897
Mogensen, Olaf Einar. Engr., F. L. Smidth & Co., 50 Church St., Room 459, New York City. (*Assoc. M., April 7, 1897*)	Sept. 2, 1903
Mogensen, Peter. 1707 Eighth Ave., Spokane, Wash.	July 10, 1907
Mohun, Edward. Union Club, Victoria, B. C., Canada	April 6, 1892
Moir, Ernest William. 10 Victoria St., Westminster, London, England	Sept. 7, 1904
Moisseiff, Leon Solomon. Engr. in Chg., Dept. of Bridges, Park Row Bldg., New York City. (*Jun., Dec. 3, 1895; Assoc. M., Sept. 5, 1900*).	Dec. 3, 1907
Molera, Eusebius Joseph. 2025 Sacramento St., San Francisco, Cal.	Oct. 5, 1904
Molitor, David Albert. Prof. of Topographic and Geodetic Eng., Cornell Univ., Ithaca, N. Y.	Oct. 6, 1897
Molitor, Frederic. Cons. Engr., 2 Rector St., New York City	Nov. 4, 1896
Moncrieff, Alexander Bain. Railways Commr., Adelaide, South Australia.	July 4, 1894
Moncrieff, John Mitchell. Pearl Bldgs., Newcastle-upon-Tyne, England.	Nov. 3, 1897
Moncure, William Augustus. Engr. of R. of W., P. R. R., Broad St. Station, Philadelphia, Pa. (*Jun., June 21, 1894; Assoc. M., Oct. 7, 1896*).	June 5, 1906
Monroe, Richard. U. S. Asst. Engr., U. S. Engr.'s Office, Rock Island, Ill.	June 1, 1909
Monroe, Will Klahr. Engr. in Chg. of Estimating, The Brown Hoisting Machinery Co., Cleveland, Ohio	Oct. 7, 1908
Montford, Richard. Cons. Engr., L. & N. R. R., Louisville, Ky.	June 6, 1888
Montgomery, John Alexander. Cons. Engr., Room 905, First National Bank Bldg., Birmingham, Ala.	Jan. 1, 1896
Moody, Burdett. Cons. Min. Engr., 1043 San Pasqual St., Pasadena, Cal. (*Assoc. M., Feb. 3, 1897*)	June 5, 1901
Moore, Charles Edward. Cons. Engr., Santa Clara, Cal.	Jan. 7, 1880
Moore, Charles Gillingham. 12 Scott St., Buffalo, N. Y. (*Assoc. M., Mar. 5, 1902.*)	June 1, 1909
Moore, Charles Harry. Engr. of Grade Crossings, Erie R. R., Chic. & Erie R. R., Nypano R. R., N. Y., S. & W. R. R.; Chf. and Cons. Engr., Ferrocarril al Curaray, Ecuador, 50 Church St., New York City. (*Assoc. M., April 5, 1893*)	Sept. 4, 1901

	Date of Membership
Moore, Egbert Jessup. Chf. Engr., Turner Constr. Co., 11 Broadway, New York City (Res., 80 Cornell Ave., Yonkers, N. Y.) (*Jun., Mar. 31, 1903; Assoc. M., Feb. 7, 1906*)	May 31, 1910
Moore, Fred Forrest. Designing Engr., Board of Water Supply, 165 Broadway, New York City	April 3, 1907
Moore, James Edwin Alexander. Cons. and Contr. Engr. with J. W. Seaver, Cleveland, Ohio	June 5, 1901
Moore, John Edwin. Chemist for Robert W. Hunt & Co., 1121 The Rookery, Chicago, Ill	Oct. 5, 1904
Moore, John William. Chf. Engr., Indianapolis & Cincinnati Traction Co., Rushville, Ind	Feb. 2, 1909
MOORE, ROBERT. (*Past-President*). Cons. Engr., Merchants-Laclede Bldg., St. Louis, Mo	April 5, 1876
Moore, William Edwin. Cons. Engr., 220 Paulsen Bldg., Spokane, Wash.	Feb. 7, 1906
Moore, William Harley. Engr. of Bridges, N. Y., N. H. & H. R. R., New Haven, Conn	June 4, 1895
Moorshead, Thomas Courtney. Chf. Engr., Ill. Terminal R. R.; Supt. of Constr., Illinois Glass Co., Alton, Ill. (*Assoc. M., Mar. 1, 1905*)	June 30, 1910
Moran, Daniel Edward. Vice-Pres., Foundation Co., 115 Broadway, New York City. (*Assoc. M., June 3, 1891*)	Jan. 1, 1896
Mordecai, Augustus. Cons. and Const. Engr., 1328 Citizens Bldg., Cleveland, Ohio	Feb. 1, 1893
Moritz, Charles Holland. Gen. Supt., Aluminum Co. of America, Niagara Falls, N. Y. (*Assoc. M., Oct. 2, 1901*)	April 2, 1907
Morley, Fred. Lapeer, Mich. (*Assoc. M., May 6, 1891*)	Mar. 4, 1896
Morrill, Asa Hall. 44 Tremlett St., Dorchester, Mass	May 3, 1910
Morrill, George Sullivan. 44 Tremlett St., Dorchester, Mass	Mar. 2, 1887
Morris, Charles John Augustus. Cons. Engr. and Contr., P. O. Box 254, St. Paul, Minn	Oct. 3, 1883
Morris, Clyde Tucker. Prof. of Structural Eng., Ohio State Univ., Columbus, Ohio. (*Assoc. M., Mar. 6, 1907*)	Nov. 8, 1909
Morris, Henry Gurney. Engr. and Machinist, 333 Walnut St., Philadelphia, Pa	Dec. 4, 1867
Morris, Lardner Vanuxem. Chf. Engr., Bay Ridge Impvt., Long Island R. R., 1964 Broadway, Brooklyn, N. Y	May 3, 1905
Morris, Marshall. Cons. Engr., 303 Norton Bldg., Louisville, Ky	Mar. 5, 1873
Morris, Marshall, Jr. Div. Engr., H. L. Stevens & Co., Box 1129, El Paso, Tex	Feb. 1, 1910
Morris, William Cullen. Engr. of Constr., Consolidated Gas Co. of New York and The Astoria Light, Heat & Power Co., 4 Irving Pl., New York City	Oct. 7, 1908
Morrison, Harry Johnson. 201 Fremont St., Peekskill, N. Y. (*Assoc. M., Jan. 4, 1899*)	April 4, 1905
Morrison, Henry Prentice. Broadway and Forest Ave., West New Brighton, N. Y	April 6, 1898
Morrison, Thomas John. (Leary & Morrison Co., Gen. Contrs.), Fairport, N. Y	April 6, 1909
Morrow, Jay Johnson. Maj., Corps of Engrs., U. S. A., 802 Couch Bldg., Portland, Ore. (*Assoc. M., June 5, 1901*)	Mar. 1, 1904
Morse, Benjamin Franklin. 2187 E. 71st St., S. E., Cleveland, Ohio	July 12, 1877
Morse, Charles Adelbert. Chf. Engr., "Santa Fe" System, 1021 Van Buren St., Topeka, Kans	April 6, 1898
Morse, Charles James. 1825 Asbury Ave., Evanston, Ill	Feb. 6, 1884
Morse, Charles Miller. 5 Beekman St., New York City (Res., Buffalo, N. Y.)	Jan. 2, 1895
Morse, Edwin Kirtland. 1801 Commonwealth Bldg., Pittsburg, Pa	June 6, 1900
Morse, George Frederick. 601 Ave. E, Bayonne, N. J	April 3, 1907
Morse, Walter Levi. Terminal Engr., N. Y. C. & H. R. R. R. Co., Grand Central Station, New York City	May 3, 1910
Morse, William Prentiss. Asst. City Engr. of Newton, City Hall, West Newton, Mass	May 4, 1909
Morton, Walter Scott.. (Morton & Burritt), 2 Rector St., New York City.	Oct. 3, 1906
Moses, John Cranch. Engr. of Constr., The Boston Bridge Works, Inc., Cambridge, Mass. (*Jun., July 2, 1890; Assoc. M., May 4, 1898*)	May 3, 1904
Mosman, Alonzo Tyler. Asst., U. S. Coast and Geodetic Survey, Coast Survey Office, Washington, D. C	July 1, 1885
Mosscrop, Alfred Mitton. Director, Dorman, Long & Co., Ltd., Middlesbrough, England; Res., 36 East Boulevard, Rochester, N. Y. (*Jun., May 4, 1887; Assoc. M., May 3, 1893*)	Oct. 4, 1899
Moulton, Guy. Div. Engr., Middle Div., New York State Canals, Canal Office (Res., 216 West Kennedy St.), Syracuse, N. Y	Mar. 1, 1905
Mowlds, Eugene. Engr., Edge Moor Plant, Am. Bridge Co., Edge Moor, Del.	Oct. 2, 1907
Mozart, William Jacob. Cons. and Const. Engr., Flanders Rd., Westborough, Mass. (*Assoc. M., April 3, 1907*)	Jan. 31, 1911
Muenscher, Emory Washburn. County Engr., Manistee, Mich	July 5, 1893

	Date of Membership
Mueser, William. Member, Concrete-Steel Eng. Co., Park Row Bldg., New York City	Feb. 7, 1906
Muhs, Frederick Ross. Crocker Bldg., San Francisco, Cal	Oct. 7, 1908
Mulholland, William. 422 South Hill St., Los Angeles, Cal	Feb. 6, 1907
Müller, Ejnar Jönsberg. Cons. Engr., 17 Museum Rd., Shanghai, China.	Jan. 8, 1908
Münster, Andrew Wendelbo. Cons. Engr., 444 Central Bldg., Seattle, Wash	May 1, 1889
Muralt, Carl Leonard de. Prof. of Elec. Eng., Univ. of Michigan; Cons. Engr., New Eng. Bldg., Ann Arbor, Mich	Aug. 31, 1909
Murphy, Daniel William. Engr. in Chg. of Washington Office Eng., U. S. Reclamation Service, Washington, D. C	Feb. 2, 1909
Murphy, Edward Charles. Engr., U. S. Geological Survey, 2503 Elsworth St., Berkeley, Cal. (*Assoc. M., Sept. 5, 1900*)	Mar. 31, 1908
Murray, John Francis. Asst. to Chf. Engr., P. R. R., Broad St. Station, Philadelphia, Pa	Mar. 7, 1906
Murtaugh, Mark Maurice. Cons. Hydr. and Constr. Engr., Alta Club, Salt Lake City, Utah	May 1, 1907
Musson, Eugene Francis. City Engr., Norwich, N. Y	May 2, 1906
Myers, Charles Hayward. 45 Broadway, New York City	Aug. 5, 1868
Myers, Edmund Trowbridge Dana, Jr. Pres., Richmond Iron Works, Richmond, Va. (*Jun., May 2, 1888*)	June 7, 1899
Nagle, James C. Prof. of Civ. Eng., Agri. and Mech. Coll. of Texas, College Station, Tex. (*Assoc. M., April 5, 1899*)	June 6, 1905
Nauman, George. Asst. Engr., Constr., P. R. R., 406 First National Bank Bldg., Sunbury, Pa	May 4, 1904
Neale, John Colwell. Structural Engr., Carnegie Steel Co., Carnegie Bldg., Pittsburg, Pa	Jan. 7, 1903
Neeld, Charles Marshall. Mgr., Pittsburg Plant, McClintic-Marshall Constr. Co., 2243 Candace Ave., West Liberty, Pittsburg, Pa	Oct. 7, 1908
Neely, William Ridley. Asst. Engr. in Chg. of Section, Board of Water Supply of New York City, New Paltz, N. Y	July 9, 1906
Neher, Clarence Rufus. Box 724, Whitehall, N. Y	June 4, 1902
Neher, Frank. Asst. Engr., Constr. Dept., Mo. Pac. Ry., St. Louis, Mo.	Oct. 4, 1905
Neilson, George Harrison. Gen. Mgr., Braeburn Steel Co., Braeburn, Pa.	Oct. 5, 1904
Nelson, Archy Magill. Asst. Engr., Ore. Short Line R. R. & S. P. Co., Room 518, Vermont Bldg., Salt Lake City, Utah	Oct. 4, 1910
Nelson, James Augustus. Gen. Mgr., The East Jersey Pipe Co., Paterson, N. J	Mar. 2, 1909
Nethercut, Edgar S. (Parmley & Nethercut), 1517 Monadnock Blk., Chicago, Ill	April 6, 1904
Newbrough, William. Civ. and Min. Engr., Evanston, Wyo	April 6, 1904
Newell, Frederick Haynes. Director, U. S. Reclamation Service, Washington, D. C	Dec. 5, 1900
Newell, Joseph Pettus. 33 Washington Bldg., Portland, Ore	Oct. 2, 1907
Newman, Emil. Asst. Engr., Pacific Light & Power Co., 1048 West 8th St., Los Angeles, Cal	Jan. 4, 1905
Newman, Robert Morris. Jackson, Mich	May 6, 1874
Newton, Albert William. Gen. Insp., Permanent Way and Structures, C., B. & Q. R. R., Chicago, Ill	Dec 6, 1905
Newton, Ralph Eells. Pres., Newton Eng. Co., 434 Jackson St., Milwaukee, Wis. (*Assoc. M., Jan. 8, 1902*)	Feb. 2, 1909
Nichol, John. Western Springs, Cook Co., Ill. (*Assoc., Oct. 2, 1872*)	April 5, 1876
Nichols, Charles Hart. 42 East 23d St., New York City	Nov. 8, 1909
Nichols, Charles Henry. Cons. Engr.; Engr., Conn. Shell Fish Comm., New Haven, Conn. (*Jun., May 2, 1893; Assoc. M., May 2, 1900*)	Feb. 28, 1905
Nichols, Edwin Jay. Houston Heights, Tex	Sept. 2, 1896
Nichols, Lewis Abel. Cons. Engr.; Pres., Chicago Steel Tape Co., 6231 Cottage Grove Ave., Chicago, Ill	Oct. 5, 1892
Nichols, Willard Atherton. Redlands, Cal	May 7, 1873
Nicholson, Frank Lee. Chf. Engr., Norfolk & Southern R. R. Co., 218 Graydon Park, Norfolk, Va	Dec. 6, 1905
Nicolls, William Jasper. "Birch Hill Farm," Malvern, Pa	June 5, 1878
Nicolson, George Llewellyn. Gen. Mgr., C. & O. Canal, Washington, D. C	Dec. 5, 1894
NOBLE, ALFRED. (*Past-President*). 7 East 42d St., New York City. (*Jun., Sept. 2, 1874*)	April 3, 1878
Noble, Frederick Charles. Div. Engr., Public Service Comm. for the First Dist., 23 Flatbush Ave., Brooklyn, N. Y. (*Assoc. M., June 4, 1902*)	Mar. 1, 1910
Noble, Theron Augustus. Cons. Engr., 207 Miller Bldg., North Yakima, Wash	June 2, 1897
Norboe, Paul Maningham. Asst. State Engr., 3730 Magnolia Ave., Sacramento, Cal	Nov. 1, 1905
Norcross, Joseph Arnold. Secy. and Treas., The New Haven Gas Light Co., 80 Crown St., New Haven, Conn	April 5, 1905

		Date of Membership
	Norris, Robert Van Arsdale. Cons. Engr., 524 Second National Bank Bldg., Wilkes-Barre, Pa. *(Jun., Dec. 7, 1887)*	Mar. 5, 1902
N.	North, Edward P. 220 West 57th St., New York City	Dec. 4, 1867
	Norton, Albert Gray. Const. Engr. and Archt., Middletown, N. Y.	Dec. 4, 1901
	Norton, Homer Burdett. Chf. Engr., Elk Tanning Co., Ridgway, Pa.	June 3, 1908
	Nostrand, Peter Elbert. Cons. Engr. and City Surv., Beekman St., New York City. *(Assoc. M., Sept. 7, 1892)*	Mar. 6, 1895
	Noyes, Ellis Bradford. Civ. Engr.'s Office, U. S. Navy Yard, Norfolk, Va. *(Jun., July 7, 1880)*	Oct. 2, 1889
	Nuebling, Emil Louis. Supt. and Engr., Dept. of Water, Reading, Pa.	Dec. 7, 1904
	Nugent, Paul Cook. Prof. of Civ. Eng., Syracuse Univ., 417 University Pl., Syracuse, N. Y.	May 3, 1910
	Nunn, Paul N. Chf. Engr., Telluride Power Co., Provo, Utah	Sept. 7, 1904
	Nyeboe, Marius Ib. Esperance Alle 12, Charlottenlund, Denmark	July 9, 1906
	Oakes, John Calvin. Maj., Corps of Engrs., U. S. A., Custom House, Cincinnati, Ohio. *(Assoc. M., May 1, 1907)*	May 31, 1910
	Oakley, Frank Thompson. Bridge Engr., Northwestern Pacific R. R., San Francisco; Address, 2 Mesa Ave., Oakland, Cal. *(Assoc. M., Feb. 6, 1895)*	June 6, 1900
	Ober, Ralph Hadlock. Asst. City Engr., City Hall, Seattle, Wash.	Dec. 4, 1907
	O'Brien, Arthur. Cons. Engr., 1127 Sunset Ave., Utica, N. Y.	July 1, 1909
	O'Brien, Joseph Henry. With Westinghouse, Church, Kerr & Co., 10 Bridge St., New York City. *(Assoc. M., May 1, 1901)*	Sept. 5, 1905
	Ockerson, John Augustus. Cons. Engr.; Member, Mississippi River Comm., 1301 Liggett Bldg., St. Louis, Mo.	July 7, 1880
	Odell, Frederick Sylvester. Port Chester, N. Y.	Mar. 5, 1884
	O'Donnell, John Patrick. Palace Chambers, Westminster, London, S. W., England	July 5, 1893
	Oestreich, Henry Lewis. Senior Asst. Div. Engr., Public Service Comm., 565 Fifth Ave. (Res., 429 Sixteenth St.), Brooklyn, N. Y. *(Jun., Oct. 4, 1892; Assoc. M., Dec. 6, 1899)*	April 6, 1909
	Ogawa, Umesaburo. Prof. of Civ. Eng., Kyoto Imperial Univ., Kyoto, Japan.	Dec. 4, 1907
	Ogden, Henry Neely. Special Asst. Engr., State Dept. of Health, and Prof. of San. Eng., Cornell Univ., Ithaca, N. Y. *(Jun., Oct. 3, 1893; Assoc. M., Oct. 5, 1898)*	Nov. 30, 1909
	O'Hanly, John Lawrence Power. Cons. Engr., Ottawa, Ont., Canada	Sept. 5, 1883
	Olcott, Eben Erskine. Min. Engr., 36 Wall St., New York City	July 5, 1893
	Oliver, Emery. 314 Ochsner Bldg., Sacramento, Cal.	Mar. 7, 1906
	Olmsted, Ashbel Edward. Div. Engr., Rapid Transit Subway Constr. Co., 145 Audubon Ave., New York City	May 6, 1903
	Olmsted, Frank Henry. (Olmsted & Gillelen, Cons. Engrs.), 604 Wright & Callender Bldg., Los Angeles, Cal.	Feb. 7, 1900
	Olney, Alfred Clarence. 1015 Central Ave., Birmingham, Ala. *(Jun., April 30, 1895)*	Nov. 2, 1898
	Olney, LaFayette. Cons. Engr., Sea Cliff, N. Y.	Oct. 7, 1868
	Opdyke, Stacy Brown, Jr. Contr. Engr., 1931 Broadway, New York City.	Feb. 2, 1876
	Orange, James. 3 Gray's Inn Sq., London, England	Dec. 3, 1890
	O'Rourke, John Francis. Pres., O'Rourke Eng. Constr. Co.; Cons. Engr., 345 Fifth Ave., New York City	April 2, 1884
	Orr, John. Prof. of Eng., South African School of Mines and Technology, Box 1176, Johannesburg, South Africa	Oct. 4, 1910
	Orrok, George Alexander. Mech. Engr., New York Edison Co., 55 Duane St., New York City	June 6, 1906
	Osborn, Frank Chittenden. Cons. Engr., Osborn Bldg., Cleveland, Ohio.	Oct. 3, 1888
	Osgood, Joseph Otis. Chf. Engr., C. R. R. Co. of N. J., 143 Liberty St., New York City. *(Jun., May 3, 1876)*	Mar. 5, 1879
	O'Shaughnessy, Michael Maurice. Chf. Engr., Southern California Mountain Water Co.; Cons. Engr., 14 Montgomery St., San Francisco, Cal.	June 4, 1902
	Ostrander, John Edwin. Prof., Math. and Civ. Eng., Mass. Agri. Coll., Amherst, Mass. *(Jun., May 2, 1888; Assoc. M., Sept. 2, 1891)*	April 4, 1905
	Ostrom, John Nelson. Bridge Engr., 1626 Farmers Bank Bldg., Pittsburg, Pa.	Nov. 5, 1890
	Ostrup, John Christian. Prof. of Structural Eng., Stevens Inst. of Technology, Hoboken, N. J.; Cons. Engr., 17 Battery Pl., New York City. *(Assoc. M., Mar. 4, 1896)*	Mar. 1, 1899
	Otagawa, Masayuki. 57 Haramachi Itchome, Ushigomeku, Tokyo, Japan.	Jan. 2, 1895
	Otis, George Ellison. Cons. Engr., Mansfield, Ark.	July 3, 1895
	Owen, James. Cons. Engr., 196 Market St., Newark, N. J.	Sept. 15, 1869
	Owens, Henry Kinder. Chf. Engr., Hanford Irrig. & Power Co., 839 Central Bldg., Seattle, Wash.	Mar. 6, 1889
	Oxholm, Theodor Smidt. Engr. in Chg., Bureau of Eng.-Constr., Office, Pres. of the Borough of Richmond, Borough Hall, New Brighton, N. Y.	Nov. 3, 1897

	Date of Membership
Packard, Ralph Gooding. Pres. of the R. G. Packard Co., 130 Pearl St., New York City	Feb. 17, 1869
Page, Logan Waller. Director, Office of Public Roads, U. S. Dept. of Agriculture, 2223 Massachusetts Ave., Washington, D. C	July 1, 1909
Page, William Nelson. 1863 Kalorama Rd., N. W., Washington, D. C	May 3, 1905
Paget, Edmund Winter. Apartment No. 405, The Barker, N. W. Cor., 21st and Irving Sts., Portland, Ore	June 5, 1901
Paine, Arthur Bickley. Address unknown	Sept. 6, 1882
Palmer, Frederick. Chf. Engr., Port of London Authority, 109 Leadenhall St., London, E. C., England	Oct. 4, 1899
Palmer, John Elden. 32 Lindsey St., Dorchester, Mass	June 1, 1904
Palmer, John Geary. Asst. Engr., New York State Barge Canal, Montezuma, N. Y	Oct. 7, 1908
Pardee, James Thomas. Cons. Engr., 10220 Clifton Boulevard, N. W., Cleveland, Ohio. (*Assoc. M., June 5, 1895*)	June 5, 1901
Paret, Milnor Peck. 317 New York Life Bldg., Kansas City, Mo	Sept. 2, 1885
Parker, Adelbert Franklin. 380 Twenty-fifth St., Ogden, Utah	Aug. 31, 1909
Parker, Charles Jeremiah. Prin. Asst. Engr., N. Y. C. & H. R. R. R. Co., Grand Central Terminal, New York City	Feb. 7, 1900
Parker, Frederick Yancy. U. S. Engr. Office, Custom House, St. Louis, Mo.	June 1, 1909
Parker, Harold. Member, Mass. Highway Comm.; Member, Wachusett Mt. State Reservation Comm.; (Parker & Bateman), Clinton (Res., So. Lancaster), Mass	June 7, 1899
Parker, Maurice Stiles. St. Maries Hotel, St. Maries, Idaho	Feb. 5, 1890
Parker, Orlando Kenton. Cons. Engr., Box 3, R. F. D. No. 3, Los Angeles, Cal	June 6, 1906
Parker, William Pool. Chf. Engr., A. M. Blodgett Constr. Co., 411 Security Bldg., Galveston, Tex. (*Assoc. M., Oct. 5, 1904*)	Sept. 1, 1908
Parks, Charles Wellman. Civ. Engr., U. S. N.; Inspecting Engr., Gen. Elec. Works, Schenectady, N. Y	Oct. 3, 1906
Parks, Oren Elisha. Town Engr. and Engr. of Westfield Water-Works, 111 North Elm St., Westfield, Mass	Dec. 6, 1905
Parmley, Walter Camp. Cons. Engr., Everett Bldg., New York City. (*Assoc. M., April 1, 1896*)	June 1, 1898
Parsons, Burt Hewitt. Prin. Asst. Engr., Cooper & Powelson; Mech. Engr., The Keokuk & Hamilton Water Power Co., Keokuk, Iowa	Feb. 6, 1907
Parsons, Harold Ashton. 303 Main St., Stamford, Conn. (*Assoc. M., May 1, 1907*)	Dec. 6, 1910
Parsons, Harry de Berkeley. Prof. Emeritus, Rensselaer Polytechnic Inst.; Cons. Engr., 22 William St., New York City	Feb. 3, 1897
Parsons, Henry Cuyler. Tweddle Bldg., Albany, N. Y	Oct. 6, 1886
Parsons, Robert Stevens. Supt., Erie R. R., Jersey City, N. J	Sept. 6, 1905
Parsons, William Barclay. Cons. Engr., 60 Wall St., New York City. (*Jun., June 7, 1882*)	Nov. 2, 1887
Paschke, Theodore. 1 West 100th St., New York City	Mar. 7, 1894
Patch, Walter Woodbury. Project Engr., U. S. Reclamation Service, Klamath Falls, Ore. (*Assoc. M., Sept. 7, 1904*)	Jan. 7, 1908
Paterson, Harry Thomas. U. S. Asst. Engr., Newbern, N. C. (*Assoc. M., Feb. 3, 1904*)	May 4, 1909
Patrick, Mason Mathews. Lt.-Col., Corps of Engrs., U. S. A., Custom House, Norfolk, Va	Oct. 7, 1903
Patten, Henry Benjamin. 314 East 18th St., Cheyenne, Wyo	Jan. 4, 1888
Patten, William Nickels. Asst. Constr. Mgr., Stone & Webster Eng. Corporation, 147 Milk St., Boston, Mass	June 30, 1910
Patterson, John Curtis. 300 Franklin Bank Bldg., Philadelphia, Pa	Oct. 2, 1889
Patterson, William Rodney. 1448 Monadnock Blk., Chicago, Ill	May 4, 1909
Paul, Charles Howard. Constr. Engr., Arrowrock Dam, U. S. Reclamation Service, Boise, Idaho. (*Assoc. M., June 7, 1905*)	Sept. 1, 1908
Payne, Edwin Van Rensselaer. Barge Canal Res. Engr., Fort Edward, N. Y	May 6, 1908
Payne, William Arthur. Gen. Supt. of Constr. and Engr. with Charles T. Wills, Inc., 286 Fifth Ave., New York City	Feb. 1, 1910
Peabody, William Welcome. Div. Engr., Board of Water Supply, New York City, White Plains, N. Y	April 6, 1909
Pearl, James Warren. Asst. Engr., City of Chicago, 5300 So. Park Ave., Chicago, Ill	Jan. 2, 1889
Pearl, Walter. Cons. Engr., 630 Twenty-first St., Denver, Colo	June 3, 1908
Pearson, Edward Jones. Chf. Engr., Chic., Mil. & Puget Sound Ry., 617 White Bldg., Seattle, Wash	Dec. 4, 1907
Pearson, Fred Stark. Cons. Engr., 25 Broad St., New York City	Nov. 3, 1897
Peary, Robert Edwin. Civ. Engr., U. S. N., 2014 Twelfth St., N. W., Washington, D. C	Mar. 3, 1886
Peck, John Gates. Chf. Engr. and Shop Mgr. for J. B. & J. M. Cornell Co., Cold Spring, N. Y. (*Assoc. M., Sept. 3, 1902*)	Nov. 1, 1910
Pegram, George Herndon. Chf. Engr., Interborough Rap. Trans. Co. and Rap. Trans. Subway Constr. Co., 165 Broadway, New York City. (*Jun., April 7, 1880*)	Jan. 3, 1883

MEMBERS P

	Date of Membership
Peimbert, Angel. Res. Engr., S. Pearson & Son, Inc., 4a Humboldt No. 31, City of Mexico, Mexico	July 9, 1906
Pemoff, Joel Juk. Asst. Engr., Dept. of Docks and Ferries in Chg. of the Chelsea Section, Pier A, North River, New York City. (*Assoc. M., Nov. 5, 1902*)	Nov. 2, 1908
Pence, William David. Prof. of Railway Eng., Univ. of Wisconsin; Engr., Wisconsin State Board of Assessment, and Railroad Comm. of Wisconsin, Madison, Wis	Oct. 4, 1899
Penfield, William Henry. Engr. of Constr., C., M. & St. P. Ry. Co., Butte, Mont	Mar. 1, 1905
Perkins, Charles Ezra. Akron, Ohio	June 6, 1906
Perkins, Charles Penrose. 2005 De Lancey St., Philadelphia, Pa. (*Jun., Feb. 3, 1875*)	April 5, 1882
Perkins, Edmund Taylor. Pres. and Chf. Engr., Edmund T. Perkins Eng. Co., 1110 First National Bank Bldg., Chicago, Ill	Dec. 3, 1902
Perrilliat, Arsène. Cons. and Contr. Engr., 1007 Hibernia Bank Bldg., New Orleans, La. (*Assoc. M., June 7, 1893*)	April 5, 1899
Perrine, George. 820 West End Ave., New York City	April 6, 1909
Perrine, Ren Brown. Cons. Engr., Prack & Perrine, J. M. S. Bldg., South Bend, Ind	May 31, 1910
Perry, Chauncy Rusch. Greenwood Ave., Waltham, Mass. (*Assoc. M., Feb. 1, 1905*)	June 1, 1909
Peterson, Peter Alexander. Mount Royal Club, Montreal, Que., Canada.	Jan. 5, 1876
Pettee, Eugene Everett. (J. R. Worcester & Co., Cons. Engrs.), 79 Milk St., Boston, Mass. (*Assoc. M., Sept. 3, 1902*)	Mar. 2, 1909
Pettigrew, Thomas. 1170 Broadway, New York City	Oct. 4, 1893
Pew, Arthur. Cons. Engr., 619 Temple Court Bldg., Atlanta Ga	Dec. 2, 1885
Peyton, John Howe. Asst. to Pres., L. & N. R. R. Co., Louisville, Ky	June 1, 1909
Pfau, Julius Welch. Engr. of Constr., N. Y. C. & H. R. R. R., Room 1101 Grand Central Station, New York City. (*Assoc. M., Dec. 2, 1903*)	Dec. 6, 1910
Pharr, Harry Nelson. Cons. Engr., 416 Randolph Bldg., Memphis, Tenn. (*Assoc. M., Oct. 3, 1900*)	June 6, 1905
Phelps, William Collins. 165 Broadway, Room 1026 A, New York City.	Oct. 2, 1907
Philips, James Harry. Prin. Asst. to Engr. and Supt. of Essex County Park Comm., 60 Clifton Ave., Newark (Res., 41 Hawthorne Ave., Glen Ridge), N. J	Feb. 6, 1907
Phillips, Alfred Edward. Prof., Civ. Eng., Armour Inst. of Technology, 1206 Morse Ave., Chicago, Ill	May 3, 1905
Phillips, Arthur Louis. 911 Hibernia Bank Bldg., New Orleans, La	Nov. 4, 1903
Phillips, Asa Emory. Supt., Sewer Dept., D. C., District Bldg., Washington, D. C. (*Jun., Nov. 5, 1891; Assoc. M., Dec. 7, 1898*)	Sept. 4, 1901
Phillips, Frederick Clinton. Jacksonville, Fla. (*Jun., June 4, 1895; Assoc. M., April 4, 1900*)	Oct. 4, 1910
Phillips, Hiram. Cons. Engr., Suite 1000, Third National Bank Bldg., St. Louis, Mo. (*Assoc. M., Jan. 3, 1894*)	Nov. 3, 1897
Phillips, Joseph Leslie. Mgr., Gold Rd. Min. & Ex. Co., 2159 West 25th St., Los Angeles, Cal	Nov. 3, 1897
Phillips, Richard Harvey. Cons. Engr., Security Bldg., St. Louis, Mo	Dec. 7, 1904
Phillips, William Renton. 419 Lumber Exchange Bldg., Portland, Ore	June 1, 1909
Pickett, William Douglas. 228 Campsie St., Lexington, Ky	July 6, 1853
Pierce, Frederic Emery. Chf. of Constr., The New Jersey Zinc Co., 55 Wall St., New York City	Oct. 5, 1909
Pierce, Henry. Chf. Engr. of Constr., C. & O. Ry. (Res., 2243 West Grace St.), Richmond, Va	Dec. 5, 1894
Pierce-Hope, John. Mgr., Guaqui to La Paz Ry., Casilla 280, La Paz, Bolivia	Dec. 5, 1906
Pierson, George Spencer. Civ., Hydr. and San. Engr., Kalamazoo, Mich	June 5, 1889
Pihl, Olaf Ridley. 637 Wabash Bldg., Pittsburg, Pa	Oct. 2, 1889
Pillsbury, Franklin Calhoun. Div. Engr., Mass. Highway Comm., 126 Massachusetts Ave., Boston, Mass	Aug. 31, 1909
Pitcher, Samuel Henry. 418 Main St., Worcester, Mass	Mar. 2, 1909
Pitman, Frederick Longfellow. Chf. Engr., The North Coast R. R. Co., 9th Floor, Paulsen Bldg., Spokane, Wash	Oct. 5, 1909
Pitts, Thomas Dorsey. Div. Engr., Sewerage Comm., 904 American Bldg., Baltimore, Md. (*Jun., Dec. 7, 1897; Assoc. M., June 4, 1902*).	Oct. 4, 1910
Pitzman, Julius. 615 Chestnut St., St. Louis, Mo	Dec. 4, 1907
Plimpton, Arthur Leslie. Civ. Engr. in Chg. of Dept. of Civ. Eng., Boston Elev. Ry. Co., 101 Milk St., Boston, Mass	May 6, 1896
Poetsch, Charles Julius. City Engr., Milwaukee, Wis. (*Jun., May 4, 1881*).	May 2, 1883
Poland, William Babcock. Vice-Pres. and Chf. Engr., Philippine Ry. Co., Manila, Philippine Islands. (*Jun., Oct. 31, 1893; Assoc. M., May 3, 1899*)	Sept. 2, 1903
Polhemus, James Suydam. U. S. Asst. Engr., Custom House, Portland, Ore	Oct. 3, 1894
Polledo, Ysidoro. Manzaneda 16, Matanzas, Cuba. (*Jun., Jan. 2, 1889*)	Nov. 4, 1903

	Date of Membership
Polleys, William Vaughan. Supt. of Constr., Stone & Webster Eng. Corporation, P. O. Box 453, Columbus, Ga	Jan. 3, 1906
Pollock, Clarence DuBois. Asst. Engr., Highways, Borough of Manhattan, 1605 Park Row Bldg., New York City. (*Assoc. M., Jan. 8, 1902*)	April 4, 1905
Pond, Henry Otis. Tenafly, N. J	May 4, 1909
Pope, John Horton. Care, Percival Farquhar, 11 Rue Louis le Grand, Paris, France	Dec. 7, 1904
Pope, Willard. Vice-Pres. and Engr., The Canadian Bridge Co., Ltd., Walkerville, Ont., Canada	Oct. 5, 1904
Porter, Dwight. Prof. of Hydr. Eng., Mass. Inst. Tech., Boston, Mass.	Oct. 4, 1893
Porter, Henry Hobart. 52 William St., New York City	June 3, 1903
Porter, Henry Tegmeyer. Chf. Engr., Bessemer & L. E. R. R., Greenville, Pa	April 1, 1903
Poss, Victor Henry. Cons. Engr., 615 Mechanics Inst. Bldg., San Francisco, Cal	April 5, 1910
Post, George Browne. 347 Fifth Ave., New York City	Sept. 2, 1896
Post, Henry Willis. Cons. Structural Engr., 30 West 38th St., New York City	Oct. 7, 1903
Post, Walter A. Gen. Mgr., Newport News Shipbuilding & Dry Dock Co., Newport News, Va	Mar. 1, 1893
Potter, Charles Lewis. Maj., Corps of Engrs., U. S. A., U. S. Engr. Office, 428 Custom House, St. Louis, Mo	April 1, 1903
Potter, Henry Witbeck. Office Engr., Tlahualilo Agri. Co., Tlahualilo, Dgo., Mexico	Dec. 5, 1888
Potter, Herbert Leroy. 511 Eighth St., Brooklyn, N. Y	Oct. 2, 1907
Potter, William Bancroft. Engr., Railway and Traction Dept., Gen. Elec. Co., Schenectady, N. Y	Mar. 2, 1904
Potts, Clyde. Civ. and San. Engr., 30 Church St., New York City. (*Jun., Dec. 3, 1901; Assoc. M., Oct. 4, 1905*)	June 30, 1910
Powell, Ambrose Vincent. Cons. Engr., 1007 Chamber of Commerce Bldg., Chicago, Ill	Feb. 6, 1901
Powell, Archibald Olin. Cons. Engr., 404 Central Bldg., Seattle, Wash.	Mar. 2, 1898
Power, George Coffin. Saticoy, Cal	Feb. 1, 1893
Powers, Cornelius Van Vorst. Div. Engr., Public Service Comm. for the First Dist., 231 West 125th St., New York City	Mar. 1, 1905
Powers, Joseph Allen. Pres., Powers & Mansfield Co., 280 River St., Troy, N. Y. (*Jun., April 2, 1884*)	Sept. 3, 1890
Pratt, Mason Delano. Cons. Engr., 16 South Second St., Harrisburg, Pa (*Jun., Sept. 5, 1888; Assoc. M., Feb. 3, 1897*)	April 3, 1901
Pratt, William Abbott. Cons. Engr., Waynesboro, Va	July 5, 1882
Preston, Charles Henry. Archt. and Structural Engr., 43 Broadway, Norwich, Conn	Oct. 5, 1909
Preston, Charles Henry, Jr. Cons. Engr., 136 Grand St., Waterbury, Conn. (*Assoc. M., Oct. 2, 1907*)	Sept. 6, 1910
Preston, Henry Wray. Engr., Elmira Plant, Empire Bridge Co., Elmira Heights, N. Y. (*Assoc. M., May 3, 1899*)	Sept. 3, 1907
Price, William Gunn. 260 Reis St., New Castle, Pa	April 3, 1895
Prichard, Henry Sewall. Am. Bridge Co., Frick Bldg., Pittsburg, Pa.	Jan. 2, 1895
Prince, George Thomas. Cons. Engr., 1520 Champa St., Denver, Colo.	April 4, 1894
Prindle, Franklin Cogswell. Civ. Engr., U. S. N.; Rear-Admiral (*Retired*), 1752 Park Rd., Washington, D. C	Mar. 4, 1874
Prior, Charles Henry. 304 South 7th St., Minneapolis, Minn	Mar. 1, 1882
Pritchett, Charles Marcellus. Chf. Div. Engr., Bureau of Public Works, Manila, Philippine Islands. (*Assoc. M., Sept. 2, 1903*)	Jan. 4, 1910
Proal, Arthur Breese, Jr. Care, Robins Conveying Belt Co., Passaic, N. J	Mar. 7, 1906
Prout, Henry Goslee. First Vice-Pres. and Gen. Mgr., Union Switch & Signal Co., 30 Church St., New York City. (*Assoc., Nov. 6, 1872*)	Sept. 3, 1879
Pruyn, Francis Lansing. Vice-Pres., Underpinning Co., 290 Broadway, New York City. (*Jun., Dec. 1, 1896; Assoc. M., June 7, 1899*)	Mar. 2, 1909
Puffer, William Haselton. Guanajuato, Mexico	May 3, 1905
Puga, Guillermo Beltran y. Direccion de Obras Publicas, City of Mexico, D. F., Mexico	June 5, 1907
Pugh, De Witt Pawling. Asst. Engr., P. R. R., First National Bank Bldg., Monongahela, Pa	May 6, 1908
Pugh, Marshall Rogers. (Pugh & Hubbard), 601 Witherspoon Bldg., Philadelphia, Pa. (*Assoc. M., Dec. 7, 1904*)	Nov. 2, 1908
Purdon, Charles de la Cherois. Chf. Engr., St. L. & Southwestern Ry., 1342 Pierce Bldg., St. Louis, Mo	Mar. 3, 1886
Purdy, Corydon Tyler. Everett Bldg., Union Sq., North, New York City. (*Jun., Feb. 2, 1887*)	Dec. 6, 1893
Purdy, Samuel Moreau. Chf. Engr., E. E. Smith Contr. Co., 189 Fourth Ave. (Res., 470 Third St.), Brooklyn, N. Y	May 3, 1910
Putnam, George Rockwell. Commr. of Light Houses, Washington, D. C. (*Assoc. M., Feb. 1, 1899*)	June 3, 1903

	Date of Membership
Quick, Alfred Merritt. Pres., Water Board, and Water Engr., City Hall, Baltimore, Md. (*Assoc. M., Oct. 5, 1898*)	May 3, 1910
Quimby, Charles Henry, Jr. Res. Engr., New York, Westchester & Boston Ry., 105 Madison St., Mt. Vernon, N. Y. (*Assoc. M., Dec. 4, 1907*)	June 30, 1910
R. Quimby, Henry Hodge. Cons. Bridge Engr., 3920 Girard Ave., Philadelphia, Pa.	Sept. 3, 1890
Quinby, Edwin Rufus. Chf. Engr., Con. Tel. & Elec. Subway Co., 66 Lafayette St., New York City	May 4, 1904
Quinn, Richard. U. S. Asst. Engr., Hilo, Hawaii	Mar. 2, 1904
Quinton, John Henry. Cons. Engr., U. S. Reclamation Service, 604 Wright & Callender Bldg., Los Angeles, Cal.	Feb. 7, 1900
Quintus, John Charles. U. S. Asst. Engr., 540 Federal Bldg., Buffalo, N. Y.	Jan. 2, 1889
Raasloff, Harald de. 18 Burling Slip, New York City. (*Jun., Dec. 3, 1884*)	July 3, 1895
Rablin, John Richard. Chf. Engr., Met. Park Comm., 14 Beacon St., Boston, Mass.	Aug. 31, 1909
Radenhurst, William Napier. 16 Scio St., Rochester, N. Y. (*Jun., July 7, 1875*)	July 7, 1880
Raikes, Hugh Percival. 63 Temple Row, Birmingham, England. (*Assoc. M., June 6, 1906*)	July 1, 1909
Ralston, John Chester. Cons. Engr., 2421 West Mission Ave., Spokane, Wash.	Oct. 3, 1906
Ramsey, Joseph, Jr. 100 Broadway, New York City (Res., 157 Raymond Ave., South Orange, N. J.)	May 1, 1889
Randall, Henry Irwin. Natron, Lane Co., Ore.	Feb. 7, 1906
Randle, George Nelson. City Engr., City Hall, Sacramento, Cal.	Feb. 2, 1909
Randolph, Beverly Strother. Civ. and Min. Engr., Berkeley Springs, W. Va.	May 2, 1888
Randolph, Isham. Cons. Engr., 748 First National Bank Bldg., Chicago, Ill.	Feb. 4, 1903
Randolph, Lingan Strother. Prof., Mech. Eng., Virginia Polytechnic Inst., Blacksburg, Va.	Jan. 2, 1890
Raster, Walther. Office Mgr., E. C. & R. M. Shankland, 1106 The Rookery, Chicago, Ill. (*Jun., Feb. 4, 1902; Assoc. M., Mar. 6, 1907*)	Dec. 6, 1910
Ray, Frederick George. Prin. Asst. Engr., U. S. Lake Survey, 33 Campau Bldg., Detroit, Mich.	April 6, 1909
Ray, George Joseph. Chf. Engr., D., L. & W. R. R., Hoboken (Res., East Orange), N. J.	June 3, 1908
Raymer, Albert Reesor. Asst. Chf. Engr., Pitts. & Lake Erie R. R. Co., Pittsburg, Pa.	Mar. 1, 1910
Raymond, Alfred. Gen. Mgr., Drainage, Sewerage and Water Board of New Orleans, 503 City Hall Annex, New Orleans, La.	Sept. 6, 1910
Raymond, Charles Walker. Brig.-Gen., U. S. A. (*Retired*), Room 344, Bourse Bldg., Philadelphia, Pa.	June 1, 1892
Raymond, Charles Ward. Care, Ashton & Salisbury, Guaymas, Sonora, Mexico. (*Jun., Nov. 7, 1877*)	April 7, 1886
Raymond, William Galt. Prof., Civ. Eng.; Dean, Coll. of Applied Science, State Univ. of Iowa; Cons. Engr., Iowa City, Iowa	Oct. 3, 1894
Rea, Samuel. Third Vice-Pres., P. R. R. Co., 225 Broad St. Station, Philadelphia, Pa.	June 4, 1884
Reaburn, De Witt Lee. Div. Engr., Los Angeles Aqueduct, Surrey, Cal. (*Assoc. M., April 6, 1904*)	Nov. 30, 1909
Read, Robert Leland. 68 Summer St., Malden, Mass.	Sept. 2, 1874
Reber, Henry Linton. Gen. Mgr., Kinloch Telephone Co., Kinloch Bldg., St. Louis, Mo.	May 4, 1904
Redlich, Carl. R. R. Oberbaurat, Wien IX Garnisongasse 3, Vienna, Austria	Sept. 7, 1904
Reed, David Abell. Div. Engr., Wisconsin Central Ry., 422 Lyceum Bldg., Duluth, Minn.	Mar. 4, 1896
Reed, Melville Emerson. Cons. Engr., 314 Lewis Bldg., Portland, Ore.	Mar. 6, 1901
Reed, Paul Lyon. Civ. Engr., U. S. N., Bureau of Yards and Docks, Navy Dept., Washington, D. C.	July 9, 1906
Reed, Wendell Monroe. Dist. Engr., Texas and New Mexico, U. S. Reclamation Service, El Paso, Tex.	Oct. 5, 1904
Reed, William Boardman. Pres., O. & H. R. R. Co., 420 East 25th St., New York City. (*Assoc. M., Feb. 6, 1895*)	May 1, 1901
Reeves, David. Pres., The Phœnix Iron Co. and Phœnix Bridge Co., 410 Walnut St., Philadelphia, Pa. (*Jun., April 1, 1874*)	May 3, 1882
Reeves, Harley Edson. U. S. Junior Engr., Rock Falls, Ill.	Jan. 4, 1910
Reichmann, Albert Ferdinand. Res. Engr., Am. Bridge Co., 1305 Commercial National Bank Bldg., Chicago, Ill. (*Jun., April 30, 1895; Assoc. M., Oct. 5, 1898*)	Mar. 4, 1903
Reimer, William Henri Vale. 52 N. Maple Ave., East Orange, N. J.	Mar. 6, 1907

	Date of Membership
Renshaw, Alfred Howard. Noroton, Conn	June 1, 1898
Reynders, John Van Wicheren. Vice-Pres., The Pennsylvania Steel Co., Steelton, Pa. (*Assoc. M., June 1, 1892*)	Mar. 3, 1897
Reynolds, Abraham Moreau. Engr. and Supt., Essex County Park Comm., 60 Clifton Ave., Newark, N. J	Nov. 30, 1909
Rhett, Edmund Moore. Elec. Engr., Cent. of Ga. Ry. Co., Savannah, Ga. (*Jun., Nov. 4, 1902*)	Oct. 4, 1910
Rhines, George Volney. Structural Engr. with Geo. S. Mills, Archt., 1234 Ohio Bldg., Toledo, Ohio. (*Assoc. M., June 3, 1903*)	Feb. 1, 1910
Riblet, Byron Christian. 2318 West Pacific Ave., Spokane, Wash	July 1, 1908
Rice, George Staples. Engr. of Subway Constr., Public Service Comm. for First Dist., 154 Nassau St., New York City	Feb. 1, 1882
Rice, Walter Percival. Cons. Engr. (The Walter P. Rice Eng. Co.), 606 Osborn Bldg., Cleveland, Ohio	Mar. 6, 1889
Rich, Edward Dunbar. Asst. Prof. in Civ. Eng., Univ. of Michigan, 901 Forest Ave., Ann Arbor, Mich	Nov. 4, 1908
Rich, Isaac. Asst. Engr., N. Y., N. H. & H. R. R., Room 469, South Station, Boston, Mass	May 6, 1903
Richards, Albert Lennox. U. S. Asst. Engr., Care, U. S. Engr.'s Office, Rock Island, Ill	Jan. 2, 1901
Richards, Frederick David. Room 311, City Hall, Cleveland, Ohio	Jan. 31, 1911
Richards, Joseph Thomas. Chf. Engr., M. of W., P. R. R. Co., Broad St. Station, Philadelphia, Pa	April 4, 1894
Richardson, Clifford. Cons. Engr., 30 Church St., New York City. (*Assoc., Oct. 4, 1892*)	Feb. 4, 1908
Richardson, Joshua Wilson. Chf. Engr., Vera Cruz Terminal Co., Ave. Independencia No. 2, Vera Cruz, Mexico	Dec. 6, 1910
Richardson, Thomas Franklin. Chf. Civ. Engr., J. G. White & Co., Inc., 43 Exchange Pl., New York City (Res., 649 East 23d St., Brooklyn, N. Y.)	Nov. 4, 1885
Ricker, George Alfred. 702 Ellicott Sq., Buffalo, N. Y. (*Jun., April 7, 1886; Assoc. M., May 1, 1895*)	April 3, 1901
Ricketts, Louis Davidson. Cananea, Sonora, Mexico	Oct. 5, 1904
Ricketts, Palmer Chamberlaine. Pres. of, and Prof. of Mechanics, Rensselaer Polytechnic Inst., Troy, N. Y. (*Assoc., Feb. 3, 1886*)	Oct. 5, 1887
Rickey, James Walter. Chf. Engr., Long Sault Development Co., Massena, N. Y. (*Assoc. M., Sept. 3, 1902*)	April 4, 1905
Rickon, Frederic John Henry. Rickon-Ehrhart Eng. & Constr. Co., 1859 Geary St., San Francisco, Cal	Jan. 4, 1888
Ridgway, Arthur Osbourne. 608 Equitable Bldg., Denver, Colo	Jan. 31, 1911
RIDGWAY, ROBERT. (*Director*). Dept. Engr., Board of Water Supply of the City of New York, 236 Main St., Poughkeepsie, N. Y. (*Jun., Feb. 1, 1888*)	June 3, 1903
Riegner, Wallace Berkley. Engr. of Bridges, P. & R. Ry., Reading Terminal, Philadelphia, Pa	Sept. 7, 1904
Riffle, Franklin. Mgr., Iron and Pipe Depts., Dunham, Carrigan & Hayden Co., 130 Kansas St., San Francisco, Cal	Nov. 7, 1888
Riggs, Henry Earle. (The Riggs & Sherman Co., Cons. Engrs.), 613 Nasby Bldg., Toledo, Ohio. (*Assoc. M., Oct. 4, 1893*)	April 1, 1896
Riggs, Morris John. Mgr., Toledo Plant, Am. Bridge Co., Toledo, Ohio.	Dec. 6, 1899
Righter, Addison Alexander. Director and Engr., John M. Ewen Co., 525 The Rookery, Chicago, Ill	Jan. 4, 1910
Rights, Lewis Daniel. Contr. Mgr., Lewis F. Shoemaker & Co., 45 Broadway, New York City. (*Assoc. M., Mar. 5, 1902*)	Sept. 1, 1908
Ripley, Henry Clay. Cons. Engr., 58 Avenida Central, Rio de Janeiro, Brazil	Oct. 7, 1896
Ripley, Herbert Lawrence. Engr., Constr., N. Y., N. H. & H. R. R., New Haven (Res., 542 Washington Ave., West Haven), Conn	Oct. 7, 1908
Ripley, John Wesley. Secy. and Treas., The Robbins-Ripley Co., 50 Church St., New York City	May 1, 1907
Ripley, Joseph. Member, Advisory Board of Engrs. for State Canals, State Hall, Albany, N. Y	Sept. 4, 1901
Rippey, Samuel Howard. Cons. Engr., Stephen Girard Bldg., Philadelphia (Res., Upsal St., West of Wayne Ave., Germantown), Pa	May 6, 1908
Riser, Knud Sophus. Cons. Civ. and Architectural Engr., 615 The Gilbert, Grand Rapids, Mich	Feb. 3, 1892
Ritchie, George Alexander. Hotel Metropolitano, Bogota, Colombia	May 6, 1908
Ritchie, James. Cons. Engr., 516 Electric Bldg., Cleveland, Ohio	Nov. 5, 1890
Rittenhouse, Walter Britton. Paonia, Colo	April 6, 1909
Ritter, Louis E. (Ritter & Mott), 1707 Marquette Bldg., Chicago, Ill	Oct. 4, 1905
Rix, Edward Austin. Pneumatic Engr.; Pres., Rix Compressed Air & Drill Co., 219 Spear St., San Francisco, Cal	April 7, 1897
Robbins, Allan Appleton. Pres., Robbins-Ripley Co., 50 Church St., New York City. (*Assoc. M., Oct. 2, 1901*)	Sept. 6, 1904
Robbins, Samuel Bostwick. Chf. Engr., Montana Reservoir & Irrig. Co., Bach-Cory Bldg., Great Falls, Mont	Sept. 6, 1905

MEMBERS R

	Date of Membership
Roberts, George Thomas. Contr., 401 D. S. Morgan Bldg., Buffalo, N. Y. (*Assoc. M., Sept. 3, 1902*)	Mar. 3, 1908
ROBERTS, PERCIVAL, Jr. (*Director*). 717 Arcade Bldg., Philadelphia, Pa. (*Assoc., May 7, 1879*)	June 4, 1884
Roberts, Shelby Saufley. 1454 Second St., Station E, Louisville, Ky. (*Assoc. M., April 5, 1905*)	Jan. 7, 1908
Roberts, William Jackson. Cons. Engr., Medford, Ore. (*Assoc. M., June 6, 1900*)	Sept. 3, 1907
Robertson, Marshall Pope. Member, State Board of Engrs. of Louisiana, 904 North Boulevard, Baton Rouge, La. (*Assoc. M., Mar. 5, 1902*)	Sept. 4, 1906
Robinson, Albert Alonzo. 900 Tyler St., Topeka, Kans.	May 5, 1880
Robinson, Albert Fowler. Bridge Engr., A., T. & S. F. Ry. System, 1000 Railway Exchange Bldg., Chicago, Ill.	Nov. 2, 1887
Robinson, Arthur Wells. 14 Phillips Sq., Montreal, Que., Canada	Feb. 3, 1892
Robinson, Erdis Geroska. Secy.-Treas., S. W. Robinson & Son Co., 515 West First Ave. (Res., 355 West Ninth Ave.), Columbus, Ohio	Mar. 2, 1909
Robinson, George Loomis. Pres., New York Sewage Disposal Co., 1 Madison Ave., New York City. (*Jun., April 5, 1904; Assoc. M., Mar. 7, 1906*)	Dec. 6, 1910
Robinson, John Mason. Prin. Asst. Engr., Madeira-Mamoré Ry., Box 304, Manãos, Brazil	Nov. 1, 1910
Robinson, William Harper. City Engr., City Hall, Manila, Philippine Islands	Mar. 1, 1910
Rockwell, James Vincent. Civ. Engr., U. S. N.; Asst. to the Civ. Engr., U. S. Navy Yard, Brooklyn, N. Y. (*Jun., April 3, 1900; Assoc. M., Feb. 4, 1903*)	Nov. 5, 1907
Rockwell, Samuel. Chf. Engr., L. S. & M. S. Ry. Co., Cleveland, Ohio.	Jan. 7, 1880
Rockwood, Arthur Jones. Cons. Engr. and Contr., 407 Cutler Bldg., Rochester, N. Y.	Feb. 1, 1905
Rodd, Thomas. Chf. Engr., Penn. Lines W. of Pitts., Union Station, Pittsburg, Pa.	June 5, 1878
Rogers, Edwin Henry. City Engr. of Newton, City Hall, West Newton, Mass.	Jan. 2, 1907
Rogers, George Hamilton. 5 East 42d St., New York City	July 1, 1909
Rogers, Walter Alexander. Pres., Bates & Rogers Constr. Co., 885 Old Colony Bldg., Chicago, Ill. (*Jun., Sept. 10, 1891; Assoc. M., Nov. 3, 1897*)	April 4, 1900
Rohrer, Grant. Contr., 299 Broadway, New York City	July 1, 1909
Rohrer, Jacob Bomberger. Civ. Engr. and Contr., 336 North Duke St., Lancaster, Pa.	Nov. 6, 1907
Rohwer, Henry. Cons. Engr., Fullerton Bldg. (Res., 5646 Cates Ave.), St. Louis, Mo.	April 1, 1903
Rollins, Charles Ward. Chf. Engr., Neches Canal, China, Tex.	April 5, 1910
Rollins, James Wingate, Jr. Pres., Holbrook, Cabot & Rollins, Corporation, Contrs., 922 Beacon Bldg., Boston, Mass.	Nov. 7, 1900
Rommel, George, Jr. Cons. Engr., Board of Bond Trustees, Pensacola, Fla. (*Jun., Jan. 3, 1899; Assoc. M., Mar. 5, 1902*)	Oct. 2, 1906
Rood, Henry Martyn. 163 William St., Port Chester, N. Y.	Dec. 3, 1890
Ropes, Horace. 11 Chestnut Pl., Brookline, Mass.	Sept. 2, 1903
Rose, Charles Clemons. Supt., Coal Dept., The D. & H. Co., Scranton, Pa.	April 4, 1888
Rosenberg, Theodore. Cons. Civ. and Hydr. Engr., Glenwood Springs, Colo.	Jan. 4, 1910
Rosencrans, Edwin John. Archt. (Jackson & Rosencrans), 231 West 39th St., New York City	May 7, 1902
Rosencrans, William Henry. Cons. Engr., 110 La Salle St., Chicago, Ill.	Oct. 5, 1898
Ross, Alexander Bell. Representative, Missouri Val. Bridge & Iron Co. of Leavenworth, Kans., City of Mexico, Mexico	May 2, 1900
Ross, Douglas William. Chf. Engr., Sacramento Val. Irrig. Co., Willows, Cal.	Mar. 1, 1899
Ross, Elmer Wayland. Asst. Engr., Bridge Dept., City Engr.'s Office, Providence, R. I. (*Jun., Mar. 5, 1890; Assoc. M., June 1, 1892*)	April 3, 1906
Ross, Florian Gaie. Cons. Engr., 307 Fifth Ave., Pittsburg, Pa.	Dec. 2, 1903
Ross, James. 112 St. James St., Montreal, Que., Canada	Sept. 6, 1882
Rostock, John Henry. Prin. Asst. Engr., U. S. Engr.'s Office, 39 Whitehall St., Room 710, New York City	May 3, 1910
Rotch, William. 131 State St., Boston, Mass.	Mar. 5, 1873
Rourke, Louis Keegan. Supt. of Streets, Room 47, City Hall, Boston, Mass.	July 1, 1909
Rowell, George Freeman. Res. Engr., Chattanooga & Tennessee River Power Co., Guild, Tenn. (*Jun., May 4, 1897; Assoc. M., Jan. 2, 1901*)	Jan. 4, 1910
Rowland, Charles Bradley. Vice-Pres., The Continental Iron Works, West and Calyer Sts., Brooklyn, N. Y.	May 1, 1895
Rowland, Charles Leonard. Pres., Am. Welding Co., Carbondale, Pa.	Sept. 1, 1886
Rowland, Thomas Fitch, Jr. Pres., The Continental Iron Works, West and Cayler Sts., Brooklyn, N. Y.	Sept. 1, 1886

	Date of Membership
Rowse, Albert Owen. Asst. U. S. Engr., 208 West 7th St., Sterling, Ill.	Mar. 4, 1908
Roy, Robert Maitland. Mgr., The Hamilton Bridge Works Co., Ltd., Hamilton, Ont., Canada. (*Assoc. M., Oct. 3, 1900*)	Mar. 5, 1907
Ruddle, John. Mauch Chunk, Pa	Oct. 3, 1894
Ruggles, William Burroughs. 4620 Twenty-second Ave., N. E., Seattle, Wash	April 7, 1886
RUNDLETT, LEONARD W. (*Director*). Commr. of Public Works, St. Paul, Minn	Sept. 5, 1883
Ruple, Commodore Perry. Secy. and Treas., The C. H. Fath & Son Constr. Co., 516 Electric Bldg., Cleveland, Ohio	Mar. 5, 1902
Rushmore, David Barker. Chf. Engr., Power and Min. Dept., Gen. Elec. Co., Schenectady, N. Y	Jan. 2, 1907
Russell, Richard Lord. Chf. Engr., Chas. Cranford; Chf. Engr., Borough Development Co., 186 Remsen St., Brooklyn, N. Y. (*Jun., Feb. 5, 1895; Assoc. M., April 3, 1901*)	Sept. 4, 1906
Russell, Samuel Moorhead. Supt., Tol., Peoria & West. Ry. Co., Union Station, Peoria, Ill	Sept. 6, 1905
Russell, Silas Bent. Secy., Parker-Russell Min. & Mfg. Co., 508 Liggett Bldg., St. Louis, Mo. (*Jun., June 4, 1884*)	June 1, 1887
Russell, William Gardner. Altura, El Paso Co., Tex	Oct. 4, 1905
Rust, Charles Henry. City Engr., Toronto, Ont., Canada	April 5, 1899
Rust, Henry Bedinger. Special Representative, The Babcock & Wilcox Co., 1110 Farmers Bank Bldg. (Res., 1177 Murray Hill Ave.), Pittsburg, Pa. (*Assoc. M., April 6, 1898*)	April 1, 1903
Ruttan, Henry Norlande. City Engr., Winnipeg, Man., Canada	Jan. 4, 1893
Ryder, Ely Morgan Talcott. Engr., M. of W., Third Ave. R. R. Co., 130th St. and Third Ave., New York City. (*Jun., Jan. 5, 1897*)	Dec. 5, 1906

Sabin, Alpheus Timothy. Columbus, Ky	April 1, 1896
Sabin, Louis Carlton. Gen. Supt., St. Marys Falls Canal, Sault Ste. Marie, Mich. (*Assoc. M., Oct. 4, 1893*)	May 7, 1902
Sackett, John Warren. Chf. Asst. Engr., U. S. Engr. Office, Jacksonville, Fla	May 2, 1894
Safford, Arthur Truman. Asst. Engr., Proprietors of Locks and Canals, 66 Broadway, Lowell, Mass	Sept. 6, 1899
Safford, Edward Stanley. Cons. Engr., Sharon, Mass	Dec. 6, 1882
Safford, Harry Robinson. Care, Edgar Allen Am. Manganese Steel Co., 193 Michigan Ave., Chicago, Ill	July 1, 1908
Sálas, Rafael Alvarez. Gen. Mgr., Cauca R. R., Cali, Colombia	Jan. 4, 1910
Samuel, George Fredrick. First Asst. City Engr., Hyde Park Hotel, Chicago, Ill	Sept. 6, 1910
Sanborn, Frank Berry. Prof. of Civ. Eng., Tufts Coll., Tufts College, Mass	Oct. 1, 1902
Sanders, William Horatio. Cons. Engr., U. S. Reclamation Service, 915 Grand View Ave., Los Angeles, Cal	Feb. 3, 1904
Sando, Will Joseph. Cons. Engr., Milwaukee Club, Milwaukee, Wis	Aug. 31, 1909
Sanford, George Otis. Project Engr., U. S. Reclamation Service, Mills River Project, Malta, Mont. (*Assoc. M., Mar. 7, 1906*)	Jan. 4, 1910
Sapp, Edward Howard. Civ. Engr., New York Shipbuilding Co., Camden (Res., Wenonah), N. J	Sept. 6, 1905
Sarle, Oliver Perry. 146 Westminster St., Providence, R. I	Jan. 2, 1901
Saunders, William Lawrence. Pres., Ingersoll-Rand Co.; Editor, *Compressed Air,* 11 Broadway, New York City	Nov. 3, 1886
Savage, Hiram Newton. Superv. Engr., Dept. of the Interior, U. S. Reclamation Service, Washington, D. C.; Address, Helena, Mont. (*Assoc. M., Mar. 7, 1894*)	Oct. 7, 1896
Savage, John Richard. Chf. Engr., L. I. R. R. Co., Jamaica, N. Y	June 7, 1905
Saville, Caleb Mills. In Chg., Third Div., Office of Chairman and Chf. Engr., Isthmian Canal Comm., Culebra, Canal Zone, Panama. (*Assoc. M., Nov. 6, 1895*)	Jan. 2, 1901
Sawyer, Walter Howard. Hydr. Engr. and Agt., Union Water Power Co., 11 Lisbon St., Lewiston, Me	May 2, 1906
Sax, Percival Mosley. 1328 Chestnut St., Philadelphia, Pa. (*Jun., Jan. 31, 1893; Assoc. M., Jan. 3, 1900*)	April 3, 1901
Sayles, Earle Willoughby. City Engr., Watertown, N. Y	June 1, 1909
Sayles, Robert Wilson. Prin. Asst. Engr. with Chas. W. Leavitt, Jr., 220 Broadway, New York City. (*Assoc. M., April 5, 1905*)	May 5, 1908
Scaife, William Lucien. Scaife Foundry & Machine Co., 313 Sixth Ave., Pittsburg, Pa	Dec. 3, 1890
Scarborough, Francis Winthrop. Engr. and Archt. (Scarborough & Howell, Inc.), 723 E. Main St., Richmond Va. (*Jun., Sept. 3, 1890; Assoc. M., Mar. 6, 1895*)	Feb. 2, 1904
Schaeffer, Amos. Cons. Engr., Borough of the Bronx, 177th St., and 3d Ave., Bronx, New York City. (*Assoc. M., Feb. 3, 1904*)	Feb. 6, 1906

MEMBERS S

		Date of Membership
	Schall, Frederick Edward. Bridge Engr., Lehigh Val. R. R., South Bethlehem, Pa.	Oct. 1, 1902
	Scherer, Clinton Lyter. City Engr., Beaumont, Tex.	Nov. 8, 1909
	Schick, James Reese. Engr., Branch Lines, Norfolk & West. Ry. Co. (Res., 915 Nelson St.), Roanoke, Va.	Mar. 1, 1910
	Schlecht, Walter William. Care, Porto Rico Irrig. Service, Guayama, Porto Rico	April 6, 1909
	Schmidt, Max Eberhardt. Pres. and Chf. Engr., Continuous Transit Securities Co., 45 Broadway, New York City	May 7, 1879
	Schnauber, Frank Justus. 516 Kirk Bldg., Syracuse, N. Y.	Mar. 6, 1907
	Schneeweiss, Adolph Eugene. Engr., John W. Ferguson Co., Paterson, N. J.	Oct. 5, 1909
N. N. R.	SCHNEIDER, CHARLES CONRAD. (*Past-President*). Cons. Engr., Pennsylvania Bldg., Philadelphia, Pa.	Feb. 6, 1884
	Schneider, Edward John. Contr. Mgr., Am. Bridge Co. of New York, 906 Crocker Bldg., San Francisco, Cal. (*Assoc., July 9, 1906*)	Nov. 8, 1909
	Schofield, Hiram Abif. Dist. Mgr., Pittsburg Testing Laboratory, Ltd., Room 906, Crozer Bldg., Philadelphia, Pa.	Oct. 7, 1896
	Schreiber, John Martin. Engr., M. of W., Public Service Ry. Co., Public Service Bldg., Newark, N. J. (*Assoc. M., June 5, 1907*)	Nov. 30, 1909
	Schroeder, Christoffer. Architectural Engr. with C. Frank Jobson, Archt. for the Pullman Co., 415 Pullman Bldg. (Res., 6509 LaFayette Ave.), Chicago, Ill.	June 1, 1909
	Schubert, Frederick Celestine. U. S. Asst. Engr., Dalles-Celilo Canal, Drawer 7, The Dalles, Ore. (*Assoc. M., June 5, 1907*)	Feb. 2, 1909
	Schultz, Albert Louis. Cons. Engr., 817 North Highland Ave., Pittsburg, Pa.	Sept. 4, 1901
	Schultze, Paul. County Supt. of Highways, Oneida County, Utica, N. Y. (*Assoc. M., Nov. 2, 1898*)	June 5, 1901
	Schulz, Walter Frederick. Engr. of Constr., Memphis Union Station Co., 681 Rayburn Boulevard, Memphis, Tenn.	Oct. 4, 1910
	Schulze, Henry Atherton. Archt., 512 East 17th St., East Oakland, Cal.	Oct. 2, 1907
R. R.	Schuyler, James Dix. Cons. Engr., Suite 1115, Union Trust Bldg., Los Angeles, Cal.	Dec. 6, 1882
	Scofield, Edson Mason. Pres., Scofield Eng. Co., Philadelphia, Pa. (*Assoc. M., April 1, 1896*)	May 2, 1905
	Scofield, Glenn Mason. Cons. Engr., 1324 Arcade Bldg., Philadelphia, Pa.	Sept. 7, 1904
	Scorgie, James Cruickshank. Supt., Mount Auburn Cemetery, Cambridge, Mass.	Nov. 4, 1908
	Scott, Addison Moffat. Charleston, Kanawha Co., W. Va.	June 2, 1886
	Scott, Ernest Kay. Care, Hoover & Mason, 1407 Railway Exchange, Chicago, Ill.	Mar. 2, 1898
	Scotten, Frank. Supt., Constr. Dept., Great Falls Water Power & Townsite Co., Great Falls, Mont.	Aug. 31, 1909
	Scovill, Edward Tracy. Dansville, N. Y.	Sept. 6, 1876
	Scripture, Arthur Marquis. New Hartford, N. Y. (*Assoc. M., June 3, 1896*)	Jan. 5, 1904
	Seaman, Henry Bowman. Cons. Engr., 165 Broadway, New York City. (*Jun., June 2, 1886*)	Dec. 7, 1887
	Searles, William Henry. Cons. Engr., Elyria, Ohio	July 2, 1873
	Sears, Alfred Francis. 52 East 6th St., North, Portland, Ore.	June 2, 1869
	Sears, Walter Herbert. 220 Sandwich St., Plymouth, Mass.	Oct. 5, 1904
N.	Seddon, James Alexander. Address unknown	Nov. 2, 1898
	Selander, John Einar. Care, Baker & Shelford, Cons. Engrs., Westminster, London, England	Nov. 4, 1908
	Sellew, Francis Libby. Project Engr. U. S. Reclamation Service, Yuma, Ariz. (*Assoc. M., Dec. 5, 1906*)	July 1, 1909
	Seltzer, Harry Kent. Engr. of Constr., Union Bridge & Constr. Co., 903 Sharp Bldg., Kansas City, Mo. (*Jun., Feb. 4, 1896; Assoc. M., Jan. 2, 1901*)	April 3, 1906
	Sengoku, Mitsugu. 21 Fujimicho Azabu, Tokyo, Japan	June 4, 1890
	Serber, David Charles. 107 Oak Terrace, Los Angeles, Cal.	April 6, 1909
	Sergeant, George, Jr. (Sergeant-Maxwell Co.), 103 Park Ave., New York City	April 2, 1902
	Seurot, Paul Albert. 5 Rue Chambiges, Paris, France. (*Jun., April 30, 1895; Assoc. M., Oct. 4, 1899*)	Nov. 1, 1904
N.	Sewell, John Stephen. Vice-Pres. and Gen. Mgr., Alabama Marble Co., Gantts Quarry, Ala.	April 5, 1905
	Shailer, Robert Ames. Cons. Engr., 101 Tremont St., Room 304, Boston, Mass.	Mar. 3, 1880
	Shand, Gadsden Edwards. 1831 Pendleton St., Columbia, S. C.	Nov. 7, 1906
	Shand, James. Obras del Puerto, Salina Cruz, Oaxaca, Mexico	Oct. 2, 1907
	Shankland, Edward Clapp. (E. C. & R. M. Shankland), 1106 Rookery, Chicago, Ill.	Feb. 5, 1890
	Shankland, Ralph Martin. 1106 Rookery Bldg., Chicago, Ill.	Mar. 1, 1899

	Date of Membership
Shanks, Oscar. Care, Ball Eng. Co., Praetorian Bldg., Dallas, Tex.	July 9, 1906
Shanly, James Moore. 316 Prince Arthur St., West, Montreal, Que., Canada	July 6, 1887
Shannahan, John Newton. Vice-Pres. and Gen. Mgr., Washington, Baltimore & Annapolis Elec. Ry. Co., Baltimore, Md. *(Jun., Oct. 4, 1898; Assoc. M., Mar. 6, 1901)*	May 5, 1908
Shattuck, Orville Frank. City Engr., Greeley, Colo.	July 1, 1908
Shaw, Enos Larkin. 1105 Monadnock Blk., Chicago, Ill. *(Jun., Oct. 3, 1893; Assoc. M., June 1, 1898)*	Mar. 6, 1906
Shaw, George Harry Thornton. Apartado, No. 1979, City of Mexico, Mexico	Oct. 4, 1910
Shaw, Granville Wheaton. U. S. Asst. Engr., P. O. Box 496, Louisville, Ky.	Oct. 5, 1887
Shaw, Sumner Farnham. Chf. Engr., Cuba R. R., Camagüey, Cuba	Oct. 3, 1894
Sheal, Robert Erwin. Engr., Care, The Wellman-Seaver-Morgan Co., Cor., Central and Giddings Aves., Cleveland, Ohio	Oct. 4, 1905
Shearwood, Frederick Perry. Dominion Bridge Co., Montreal, Que., Canada	Oct. 7, 1903
Shedd, Edward Whitten. Civ. and Hydr. Engr., Providence, R. I.	May 6, 1903
Shedd, Frank Edson. Vice-Pres. and Chf. Engr., Lockwood, Greene & Co., 93 Federal St., Boston, Mass.	Feb. 6, 1907
Shedd, Joel Herbert. Cons. Engr., Providence, R. I.	Sept. 15, 1869
Shenehon, Francis Clinton. Dean, Coll. of Eng., Univ. of Minnesota, Minneapolis, Minn.	May 7, 1902
Shepard, David Chauncey. 324 Dayton Ave., St. Paul, Minn.	May 2, 1883
Shepard, Henry Hudson. Care, R. P. Buchanan, Glendale, Ohio	Feb. 5, 1908
Shepherd, Frank Cummings. Constr. Supt., J. G. White & Co., Inc., Jackson, Ga. *(Assoc. M., Oct. 5, 1904)*	Feb. 1, 1910
Sheppard, Charles Alfred. 115 Purcell St., Edwardsville, Ill.	Nov. 30, 1909
Sherman, Charles Winslow. Prin. Asst. Engr. with Metcalf & Eddy, Cons. Engrs., 14 Beacon St., Boston, Mass. *(Jun., Oct. 8, 1891; Assoc. M., May 2, 1900)*	Feb. 4, 1903
Sherman, Edward Clayton. Designing Engr., Isthmian Canal Comm., Culebra, Canal Zone, Panama. *(Assoc. M., Jan. 3, 1906)*	Feb. 1, 1910
Sherman, Herbert Ellwood. Asst. Engr. in Chg. of Dept. of Street Lines, City Engr.'s Office, Providence, R. I.	Mar. 7, 1900
Sherman, LeRoy Kempton. Asst. Engr., San. Dist. of Chicago, 1500 Am. Trust Bldg., Chicago, Ill.	Sept. 6, 1910
Sherman, Richard Willette. Pres., Troy Public Works Co., Utica, N. Y.	Oct. 6, 1886
Sherman, Walter Justin. (The Riggs & Sherman Co., Cons. Engrs.), 613 The Nasby Bldg., Toledo, Ohio	May 4, 1909
Sherrerd, John Maxwell. Gen. Sales Agt., Taylor Iron & Steel Co., 340 Spring Garden St., Easton, Pa.	July 10, 1907
Sherrerd, Morris Robeson. Chf. Engr., Dept. of Public Works, City Hall, Newark, N. J. *(Assoc. M., May 3, 1893)*	May 6, 1896
Shiraishi, Naoji. Care, Branch Office, Mitsu Bishi Co., Kobe, Japan	Oct. 4, 1899
Shmeleff, Theodor Semenovitch. Engr., Russian Imperial Civ. Service, Novorossiisk, Caucasus, Russia	Sept. 7, 1892
Shoemaker, Louis Henry. Engr. in Chg., Design, Am. Bridge Co., Frick Bldg., Pittsburg, Pa. *(Assoc. M., Oct. 4, 1899)*	Sept. 6, 1910
Shoemaker, Marshall Ney. Vice-Pres., Am. Concrete Steel Co., 718 Union Bldg., Newark, N. J. *(Assoc. M., April 1, 1903)*	Jan. 3, 1911
Shuman, Edward Peter. Div. Engr., Bureau of Public Works, Manila, Philippine Islands	Oct. 2, 1907
Sibert, William Luther. Maj., Corps of Engrs., U. S. A.; Supervisory Engr., Dept. of Constr. and Eng., Isthmian Canal Comm., Culebra, Canal Zone, Panama	June 2, 1897
Silliman, Charles. Asst. Engr., Norfolk & West. Ry. (Res., 926 Nelson St.), Roanoke, Va.	Mar. 1, 1910
Silva Freire, Victor da. City Chf. Engr.; Prof. of Polytechnic School, P. O. Box 18, São Paulo, Brazil	Jan. 3, 1906
Simpson, George Frederic. Asst. Engr., Rapid Transit R. R. Comm., 520 West 145th St., New York City	Mar. 2, 1887
Simpson, George Hume. 434 Shady Ave., Pittsburg, Pa.	Oct. 6, 1880
Sims, Alfred Varley. Byrdville, Va.	Mar. 4, 1896
Sims, Clifford Stanley. Second Vice-Pres. and Gen. Mgr., Delaware & Hudson Co., Albany, N. Y.	April 1, 1903
Simson, David. Ickleford Manor, Hitchin, Herts, England	Jan. 8, 1902
Sinclair, Frank Oscar. Cons. Engr. for Public Service Comm. of Vermont, Burlington, Vt.	Nov. 6, 1901
Sinks, Frank Forrest. (Condron & Sinks, Cons. Engrs.), 1214 Monadnock Bldg., Chicago, Ill. *(Assoc. M., May 2, 1906)*	June 4, 1907
Sirrine, Joseph Emory. Box 581, Greenville, S. C. *(Jun., June 20, 1893; Assoc. M., May 4, 1898)*	May 6, 1903
Sjöström, Ivar Ludwig. Vice-Pres., U. S. Worsted Co., Lawrence, Mass. *(Jun., Sept. 6, 1892)*	Sept. 1, 1897

	Date of Membership
Skilton, George Steele. Asst. Engr., Dept. of Water Supply, Gas and Electricity of City of New York, Borough of Brooklyn (Res., Rockville Center), N. Y.	Sept. 7, 1881
Skinner, Frank Woodward. Associate Editor, *Engineering Record,* 239 West 39th St., New York City	Sept. 1, 1886
Skinner, John Franklin. Prin. Asst. to City Engr., 52 City Hall (Res., 31 Somerset St.), Rochester, N. Y.	April 4, 1906
Slifer, Hiram Joseph. Gen. Mgr., Chic. Gt. West. R. R., Gas Bldg., Chicago, Ill.	June 5, 1907
Sloan, David. Chf. Engr., MacArthur Bros. Co., Contrs., 810 Fisher Bldg., Chicago, Ill.	Jan. 1, 1896
Sloan, William Griffith. Chf. Engr., MacArthur Bros. Co., 11 Pine St., New York City	Dec. 1, 1908
Slocum, Charles Mills. City Engr., 43 Bridge St., Springfield, Mass.	May 1, 1897
Smead, Raphael Chart. U. S. Asst. Engr., Federal Bldg., Dallas, Tex.	Feb. 1, 1905
Smetters, Samuel Tupper. Asst. Bridge Engr., The San. Dist. of Chicago, 15th Floor, 125 Monroe St. (Res., 6071 Jefferson Ave.), Chicago, Ill.	Sept. 6, 1910
Smith, Augustus. Pres., Bergen Point Iron Works, Foot of West 5th St., Bayonne, N. J.	June 4, 1902
Smith, Cecil Brunswick. Cons. Engr. (Smith, Kerry & Chace). Toronto, Ont., Canada	Mar. 1, 1905
Smith, Charles William. 393 Lewis Ave., Brooklyn, N. Y. (*Assoc. M., April 5, 1893*)	Dec. 1, 1903
Smith, Edwin Foster. 4102 Locust St., Philadelphia, Pa.	June 5, 1895
Smith, Eugene Raymond. Islip, Suffolk Co., N. Y. (*Jun., May 2, 1888*)	May 1, 1901
Smith, Francis Betts. In Chg. of Constr., Pearl Harbor Dry Docks, for San Francisco Bridge Co., Care, Hawaiian Dredging Co., Ltd., Honolulu, Hawaii	Jan. 2, 1907
Smith, Francis Pitt. Chemical and Cons. Paving Engr. (Dow & Smith), 24 East 21st St., New York City	Nov. 30, 1909
Smith, Gilman Walter. Div. Erecting Mgr., Am. Bridge Co. of N. Y., 1332 Commercial National Bank Bldg., Chicago, Ill.	Mar. 2, 1909
Smith, Harradon Sterling. Cons. Engr. (Smith & Welles), Coal Exchange Bldg., Wilkes-Barre, Pa. (*Assoc. M., Nov. 1, 1905*)	April 5, 1910
Smith, Henry Clement. Div. Engr., Phila. Div., P. & R. Ry., Philadelphia, Pa.	Oct. 2, 1901
Smith, Henry DeWitt. Res. Engr., T. & F. S. Ry. Co., Texarkana, Ark.-Tex.	Dec. 6, 1893
Smith, Howard Everett. Res. Engr., N. Y. State Dept. of Highways, Griffin Bldg., Syracuse, N. Y.	Nov. 6, 1907
Smith, James. 19 Bute Gardens, Muirend, Cathcart, Glasgow, Scotland. (*Assoc. M., Nov. 1, 1905*)	Mar. 31, 1908
Smith, John Herman. 3414 Wayne Ave., Kansas City, Mo.	Nov 7 1906
Smith, Jonas Waldo. Chf. Engr., Board of Water Supply of the City of New York, 165 Broadway, New York City. (*Assoc. M., Oct. 5, 1892*)	April 5, 1899
Smith, Joseph Shuter. Care, Robt. S. Perry, 5104 Pulaski Ave., Germantown, Philadelphia, Pa.	April 1, 1874
Smith, Layton Fontaine. Representative, Trussed Concrete Steel Co., of Detroit, Mich., Wilson Bldg. (Res. 2901 Calvert St.), Baltimore, Md. (*Assoc. M., June 5, 1907*)	April 5, 1910
Smith, Leonard Charles Lindsay. Cons. Engr., Queensboro Corporation Bldg., Long Island City, N. Y.	Mar. 6, 1901
Smith, Merritt Haviland. Deputy Chf. Engr., Board of Water Supply, City of New York, 165 Broadway, New York City (Res., Kensico, N. Y.). (*Jun., June 5, 1889*)	April 3, 1907
Smith, Miller Armstrong. Cons. and Contr. Engr. (Smith & Davis), 512 Lonja Bldg., Havana, Cuba	Oct. 6, 1886
Smith, Oberlin. Pres., Ferracute Machine Co., "Lochwold", Bridgeton, N. J.	Sept. 3, 1884
Smith, Robert Colfax. 1106 The Rookery, Chicago, Ill.	July 9, 1906
Smith, Stewart Kedzie. Gen. Mgr., Vinton Colliery Co., Vintondale, Pa.	April 6, 1904
Smith, T. Guilford. Mgr. of Sales, Carnegie Steel Co., Illinois Steel Co., U. S. Steel Products Export Co., Tennessee Coal, Iron & R. R. Co., 203 Ellicott Sq., Buffalo, N. Y.	Sept. 6, 1871
Smith, Walter Mickle. Designing Engr., Board of Water Supply, 165 Broadway, Room 725, New York City. (*Assoc. M., Oct. 2, 1901*)	April 3, 1906
Smith, William Charles. Chf. Engr., I. & W. N. R. R., Spirit Lake, Idaho	Sept. 4, 1901
Smith, William Sooy. Riverside, Ill.	Jan. 17, 1872
Smith, Willis Roswell. Res. Engr., The Arnold Co., Shreveport, La.	Mar. 4, 1908
Smoot, Edgar Kenneth. Concessionario Obras del Puerto de Manzanillo, 5ª Balderas 70, City of Mexico, Mexico	Feb. 2, 1898
Snell, Thomas Cullen Bryant. Structural Engr., National Board of Fire Underwriters, 464 Whalley Ave., New Haven, Conn.	July 10, 1907
Snook, Thomas Edward. 73 Nassau St., New York City	Mar. 3, 1897

	Date of Membership
Snow, Charles Henry. Dean, School of Applied Science, New York Univ., Univ. Grounds, Morris Heights, New York City. (*Assoc. M., Feb. 1, 1893*)	Sept. 2, 1896
Snow, Frank Herbert. Chf. Engr., State Dept. of Health, Harrisburg, Pa. (*Assoc. M., June 4, 1895*)	May 3, 1904
Snow, Franklin Augustus. Contr. for Public Works, The Master Bldrs. Assoc., 166 Devonshire St., Boston, Mass.	Jan. 4, 1905
Snow, Jesse Baker. Care, The Foundation Co., Helena, Mont. (Res., 330 South Lefferts Ave., Richmond Hill, N. Y.)	Oct. 2, 1907
SNOW, JONATHAN PARKER. (*Director*). Chf. Engr., B. & M. R. R., Boston, Mass.	June 3, 1885
Snow, William Pliny. 30 Woodbine St., Auburndale, Mass.	Feb. 5, 1902
Snyder, Baird, Jr. Gen. Supt., Lehigh Coal & Nav. Co., Lansford, Pa.	Mar. 2, 1904
Snyder, Christopher Henry. Contr. Mgr., San Francisco Office of Milliken Bros., New York, 607 Humboldt Bank Bldg., San Francisco, Cal.	Oct. 2, 1901
Snyder, George Duncan. Prin. Asst. Engr., Hudson & Manhattan R. R., 30 Church St., New York City. (*Assoc. M., Nov. 6, 1895*)	Sept. 4, 1901
Somerville, Robert. Asst. Chf. Engr., Board of Miss. Levee Commrs., Greenville, Miss.	June 1, 1887
Sonderegger, Arthur Ludwig. 635 Central Bldg., Los Angeles, Cal.	Oct. 5, 1909
Sonne, Otto. Civ. and Landscape Engr., 132 Nassau St., New York City.	Sept. 7, 1887
Sooysmith, Charles. Cons. Engr., 71 Broadway, New York City	May 5, 1886
Soper, George Albert. Cons. San. Engr., 29 Broadway, New York City. (*Assoc. M., Feb. 6, 1901*)	April 4, 1905
Sorzano, Julio Federico. Cons. Engr., 52 Broadway, New York City (Res., 228 Garfield Pl., Brooklyn, N. Y.)	Sept. 3, 1884
Souder, Harrison. Gen. Supt., Cornwall Ore Bank Co., Cornwall, Lebanon Co., Pa.	Jan. 6, 1904
Soulé, Frank. Prof. Emeritus of Civ. Eng., Univ. of California, 2511 Hillegass Ave., Berkeley, Cal.	Mar. 1, 1905
Soule, Howard. Syracuse, N. Y.	Mar. 17, 1869
Souther, Henry. Cons. Engr.; Pres., The Henry Souther Eng. Co., Hartford, Conn.	Dec. 4, 1907
Spalding, Frederick Putnam. Prof. of Civ. Eng., Univ. of Missouri, 901 Virginia Ave., Columbia, Mo.	Dec. 2, 1891
Spaulding, Charles Lincoln. Res. Engr., Hudson Dist., Electric Zone, N. Y. C. & H. R. R. R., 85 Main St., Yonkers, N. Y.	April 1, 1908
Speakman, Richard Edward. City Engr., Brandon, Man., Canada	Jan. 4, 1910
Spear, Walter Evans. Dept. Engr., Board of Water Supply of the City of New York, 127 Franklin St., New York City. (*Assoc. M., Feb. 3, 1904*).	Mar. 2, 1909
Spencer, John Clark. Cons. and Contr. Engr., 1024 Rockefeller Bldg., Cleveland, Ohio. (*Assoc. M., May 6, 1896*)	Dec. 6, 1904
Sperry, Henry Muhlenberg. Sales Mgr., Gen. Ry. Signal Co., P. O. Box 1052, Rochester, N. Y.	Nov. 6, 1901
Spicer, Vibé Kierulff. Gen. Mgr., Ry. Signal Co. of Canada, Ltd., Canadian Express Bldg., Montreal, Que., Canada	June 5, 1895
Spilsbury, Edmund Gybbon. Cons. Engr., 45 Broadway, New York City.	Dec. 7, 1892
Spofford, Charles Milton. Hayward Prof. of Civ. Eng., Mass. Inst. Tech., Boston, Mass. (*Assoc. M., June 4, 1902*)	June 6, 1905
Spooner, Allen Newhall. 11 West 88th St., New York City	Dec. 5, 1900
Spooner, Herman Winslow. Civ. Engr., Water Dept., 6 Proctor St., Gloucester, Mass.	Jan. 3, 1906
Sprague, Ernest Marshall. Contr. Engr., Am. Bridge Co. of N. Y., 1310 Rockefeller Bldg., Cleveland, Ohio	Oct. 3, 1906
Sprague, Frank Julian. Cons. Engr., 165 Broadway, New York City	June 1, 1904
Sprague, Norman Salisbury. Supt., Bureau of Constr., City Hall, Pittsburg, Pa. (*Assoc. M., July 10, 1907*)	May 31, 1910
Spring, Francis Joseph Edward. Engr.-Chairman, Port Trust, Madras, India	Jan. 3, 1894
Staats, John Henry. Vice-Pres. and Treas., R. P. & J. H. Staats, Engrs. and Contrs., 29 Broadway, New York City	Mar. 5, 1884
Staats, Robert Parker. (R. P. & J. H. Staats, Civ. Engrs. and Contrs.), 29 Broadway, New York City. (*Jun., Nov. 3, 1875*)	July 1, 1885
Stacpoole, Stephen Westropp. Cons. Engr., 3^{a} Avenida de la Libertad No. 5, Orizaba, Vera Cruz, Mexico. (*Assoc. M., May 6, 1896*)	Sept. 4, 1901
Staley, Cady. Care, Case School of Applied Science, Cleveland, Ohio.	Mar. 17, 1869
Stanford, Homer Reed. Civ. Engr., U. S. N., Navy Yard, Philadelphia, Pa. (*Jun., Oct. 1, 1890; Assoc. M., Nov. 7, 1894*)	Sept. 4, 1901
Staniford, Charles Wilkinson. Chf. Engr., Dept. of Docks and Ferries, Pier A, North River, New York City	May 7, 1890
Stanley, Orrin Elmore. Chamber of Commerce Bldg., Portland, Ore. (*Assoc. M., Oct. 7, 1908*)	May 31, 1910
Stanton, Frank McMillan. Min. Engr., Lincoln Trust Bldg., 208 Fifth Ave., New York City	Feb. 1, 1899
Stanton, Robert Brewster. Civ. and Min. Engr., 32 Nassau St., Room 557, New York City	Sept. 1, 1880

		Date of Membership
	Starrett, Milton Gerry. Cons. Engr., 621 Broadway, New York City	Jan. 3, 1900
	Stauffer, David McNeely. 264 Palisade Ave., Yonkers, N. Y	Sept. 2, 1874
	Stayton, Edward Moses. 423 East Kansas St., Independence, Mo. (*Assoc. M., Feb. 4, 1903*)	Nov. 5, 1907
N.	STEARNS, FREDERIC PIKE. (*Past-President*). Cons. Engr., 1 Ashburton Pl., Boston, Mass	Oct. 2, 1878
	Steece, Emmet Abner. Supt. of Constr., U. S. Public Bldgs., Fayetteville, Ark. (*Assoc. M., Dec. 4, 1901*)	Mar. 1, 1904
	Stephens, Clinton F. Chf. Engr. and Supt., Mexico, Santa Fe & Perry Traction Co., Mexico, Mo	Sept. 5, 1877
	Stephenson, James, Jr. Cons. Engr., Room 601, Idaho Bldg., Boise, Idaho	April 5, 1910
	Stern, Eugene Washington. Cons. Engr., 103 Park Ave., New York City	Mar. 3, 1897
	Stern, Isaac Farber. Engr. of Bridges, C. & N. W. R. R., 5326 Michigan Ave., Chicago, Ill	April 1, 1908
	Stevens, Frank Stoddard. Engr., M. of W., P. & R. Ry., Reading, Pa.	Oct. 3, 1883
	Stevens, Horace Edward. Director, Winston Bros. Co., Contrs., Minneapolis (Res., 530 Grand Ave., St. Paul), Minn. (*Jun., Nov. 1, 1876*).	April 4, 1888
	Stevens, Howard Eveleth. Bridge Engr., N. P. Ry. Co., St. Paul, Minn.	April 6, 1909
	Stevens, John Frank. Pres., Oregon Trunk Ry., 625 Railway Exchange, Portland, Ore	June 6, 1888
	Stewart, John Muirhead. Asst. Engr., Dept. of Docks and Ferries, East 24th St. Office, New York City. (*Jun., Mar. 2, 1887*)	Jan. 4, 1888
	Stewart, Robert Dee. Supt. and Chf. Engr., Laramie, Hahn's Peak & Pacific Ry., Laramie, Wyo	Nov. 1, 1905
	Stickle, Horton Whitefield. Capt., Corps of Engrs., U. S. A., Gatun, Canal Zone, Panama	Oct. 4, 1910
	Stickney, George Fetter. Superv. Engr., New York State Barge Canal, Barge Canal Office, Albany, N. Y. (*Jun., May 1, 1894; Assoc. M., April 5, 1899*)	Sept. 4, 1906
	Stillwell, Lewis Buckley. 100 Broadway, New York City	Oct. 2, 1901
	Stoddard, George Caleb. Civ. and San. Engr., 215 West 125th St., New York City	April 4, 1900
N.	Stone, Edward Herbert. Freshford, Somerset, England	Dec. 5, 1888
	Stone, Everett Edward. 1891 Beacon St., Brookline, Mass	May 4, 1904
	Stone, Henry Morton. Dist. Engr., C., R. I. & P. Ry., Topeka, Kans.	April 3, 1907
	Storey, William Benson, Jr. Vice-Pres., A., T. & S. F. Ry Co., 1033 Railway Exchange, Chicago, Ill	Jan. 2, 1889
	Storrow, Samuel. Civ. and Min. Engr., 906 Wright & Callender Bldg., Los Angeles, Cal. (*Jun., Sept. 10, 1891; Assoc. M., Oct. 2, 1895*)	Mar. 1, 1904
	STOTT, HENRY GORDON. (*Director*). Supt. of Motive Power, Interborough Rapid Transit Co., Rochelle Heights, New Rochelle, N. Y.	July 1, 1908
	Stowe, Harold Clair. Pres., H. C. Stowe Constr. Co., 221 Greenpoint Ave., Brooklyn, N. Y. (*Assoc. M., April 7, 1897*)	Jan. 4, 1910
	Stowell, Charles Frederick. (Stowell & Cunningham), 51 State St., Albany, N. Y	April 4, 1888
	Strachan, Joseph. 352 Putnam Ave., Brooklyn, N. Y. (*Assoc. M., May 4, 1892*)	May 4, 1898
	Strachan, Robert Charles. Richmond Hill, N. Y	Aug. 31, 1909
	Strahan, Charles Morton. Prof., Civ. Eng., Univ. of Georgia, Athens, Ga. (*Assoc. M., June 1. 1898*)	Nov. 1, 1910
	Straub, Theodore Alfred. Vice-Pres. and Gen. Mgr., Fort Pitt Bridge Works, Pittsburg, Pa	June 30, 1910
	Street, Leonard Lee. Civ. Engr. and Contr., Isaac Blair & Co., 95 Sawyer Ave., Dorchester, Mass	Oct. 5, 1909
	Strehlow, Oscar Emil. Contr. Engr., James O. Heyworth, Harvester Bldg., Chicago, Ill. (*Assoc. M., Mar. 6, 1901*)	Sept. 6, 1904
	Strickler, Gratz Brown. 921 Am. Bank Bldg., Richmond, Va. (*Jun., Jan. 5, 1897; Assoc. M., Jan. 4, 1899*)	Nov. 1, 1904
	STROBEL, CHARLES LOUIS. (*Vice-President*). Pres., Strobel Steel Constr. Co., 1744 Monadnock Blk., Chicago, Ill	Dec. 3, 1879
	Strong, Carlton. Bellefield Dwellings, Pittsburg, Pa	Jan. 4, 1910
	Strong, Mason Romeyn. Cons. Engr. and Archt., 7 Wall St., New York City	Mar. 6, 1901
	Strouse, William Franklin. Asst. Engr., B. & O. R. R. Co., Camden Station (Res., 400 Forest Rd., Roland Park), Baltimore, Md	Mar. 1, 1905
	Stuart, Alfred Allen. Cons. Engr., Degnon Contr. Co.; Secy., Degnon Realty & Terml. Impvt. Co., 60 Wall St., New York City	Oct. 7, 1891
	STUART, FRANCIS LEE. (*Director*). Chf. Engr., B. & O. R. R., B. & O. Bldg., Baltimore, Md	May 3, 1899
	Stuart, Joseph Thompson. 311 Arcade Bldg., Philadelphia, Pa	May 4, 1904
	Stubbs, Linton Waddell. Superv. Engr., Galveston Causeway, Galveston, Tex	Oct. 3, 1888
	Sturtevant, Carleton William. Supt., James Stewart & Co., Baldwinsville, N. Y	Oct. 2, 1901

	Date of Membership
Sublette, George Washington. Cons. Engr.; Const. Engr. and Contr., 1926 Aldrich Ave., South, Minneapolis, Minn.	Oct. 1, 1902
Suhr, Otto Bruno. Engr., The Ontario Power Co., Niagara Falls, N. Y.	June 1, 1904
Sullivan, James Henry. Deputy Supt. of Streets, in Chg. of Highway Div., Room 44, City Hall, Boston, Mass.	May 3, 1910
Sullivan, John G. Asst. Chf. Engr., C. P. Ry., Winnipeg, Man., Canada	Sept. 6, 1899
SUMNER, HORACE AUGUSTUS. (*Director*). Room 438, Century Bldg., Denver, Colo.	Oct. 4, 1899
Sumner, Robert Swan. Cons. Engr., Suite 438 Century Bldg., Denver, Colo. (*Assoc. M., June 3, 1903*)	Nov. 5, 1907
Sundstrom, Alfred Yngve. Bridge Engr., Mexican Ry. Co., Ltd., City of Mexico, Mexico. (*Assoc. M., June 6, 1906*)	May 31, 1910
Sundstrom, Carl Alfred. Surv. and Regulator, 8th Dist., Philadelphia, 4444 Main St., Manayunk, Philadelphia, Pa.	Oct. 3, 1894
Supplee, Jesse. Mgr., Supplee Eng. Co., Cons., Designing and Const. Engrs., Scott Blk., Erie, Pa.	June 3, 1903
Suter, Charles Russell. Brig.-Gen. U. S. A. (*Retired*), 287 Walnut St., Brookline, Mass.	April 1, 1896
Sutermeister, Arnold Henry. Engr., Public Service Comm., Second Dist., Albany, N. Y.	June 3, 1902
Sutton, Frank. Geographer, U. S. Geological Survey, Washington, D. C.	Oct. 3, 1906
Swaab, Solomon Mark. Chf. Engr., Millard Constr. Co., East Market St. Subway, 433 Market St., Philadelphia, Pa. (*Jun., May 3, 1898; Assoc. M., Nov. 1, 1899*)	May 5, 1908
Swain, George Fillmore. Prof. of Civ. Eng., Harvard Univ.; Cons. Engr., Mass. R. R. Comm.; Member, Boston Transit Comm., Pierce Hall, Oxford St., Cambridge, Mass. (*Assoc., Sept. 5, 1883*)	Mar. 2, 1892
Swanker, John Edward. Engr., David Lupton's Sons Co., Allegheny Ave. and Tulip St., Philadelphia, Pa.	May 4, 1904
Swendsen, George Lewis. Hydr. Engr., 27 Shaw Blk., Boise, Idaho	June 7, 1905
Swensson, Emil. Cons. and Constr. Engr., 925 Frick Bldg., Pittsburg, Pa.	June 7, 1893
Swezey, Edwin Charles. Gen. Supt., Brooklyn Grade Crossing Comm., 44 Court St., Brooklyn, N. Y.	Mar. 7, 1906
Swift, William Everett. Div. Engr., Hudson River Div., New York Board of Water Supply, Cornwall-on-Hudson, N. Y. (*Assoc. M., Sept. 2, 1903*)	June 30, 1910
Swinburne, George Way. 61 Whittlesey Ave., East Orange, N. J.	May 7, 1902
Sylvester, Frank McClellan. 1119 O. N. B. Bldg., Spokane, Wash.	Feb. 1, 1905
Sylvester, Ira Wallace. City Engr., Rapids Bank Bldg., Alexandria, La.	Nov. 7, 1906
Taber, George Aymar. Engr. in Chg., Constr. of Water Mains, Manhattan, Bronx and Richmond, Dept. of Water Supply, Gas and Electricity, 2032 Park Row Bldg., New York City. (*Jun., April 30, 1895; Assoc. M., June 7, 1899*)	Dec. 4, 1906
Tabor, Ernest Frederick. Project Engr., U. S. Reclamation Service, St. Ignatius, Mont.	May 1, 1907
Tainter, Frank Stone. (E. A. Stevens & Co.), 1 Newark St., Hoboken, N. J. (*Assoc. M., Jan. 3, 1900*)	Mar. 31, 1908
TALBOT, ARTHUR NEWELL. (*Director*). Prof. of Municipal and San. Eng., and in Chg. of Theoretical and Applied Mechanics, Univ. of Illinois, Urbana, Ill.	April 4, 1888
Talbott, Harry Elstner. Dayton, Ohio	June 6, 1900
Talcott, Harry Randolph. Engr. of Surveys, B. & O. R. R., Central Office Bldg., Baltimore, Md.	Oct. 5, 1904
Tanabe, Sakuro. Prof. of Civ. Eng., Kyoto Imperial Univ., Kyoto, Japan.	Oct. 4, 1905
Tatum, Sledge. Geographer in Chg., Rocky Mountain Div., U. S. Geological Survey, Washington, D. C.	Jan. 4, 1910
Taussig, Hubert Prim. Cons. Engr., 14th and Locust Sts., St. Louis Mo.	Oct. 3, 1894
Taylor, Benjamin Henry. Special Agt., Carnegie Steel Co. (Res., 323 Swissvale Ave., Edgewood Park), Pittsburg, Pa.	May 4, 1904
Taylor, Charles Frederick. Pres., Maritime Dredging Co., 78 Broad St., New York City. (*Assoc. M., Sept. 4, 1895*)	April 4, 1905
Taylor, Edward Ballinger. Third Vice-Pres., Penn. Co. and P., C., C. & St. L. Ry. Co., Room 901, Union Station, Pittsburg, Pa.	Sept. 3, 1884
Taylor, Edwin Alexander. Supt. of Constr., Water Board, 360 East 57th St., Portland, Ore. (*Assoc. M., June 7, 1905*)	June 2, 1908
Taylor, George McClellan. 2 Peters Pl., Red Bank, N. J.	Dec. 1, 1908
Taylor, Gorham Andrew. U. S. Engr.'s Office, Duluth, Minn.	Feb. 1, 1910
Taylor, Harry. Lt.-Col., Corps of Engrs., U. S. A., New London, Conn.	Oct. 7, 1896
Taylor, Howard Flanders. 800 Brighton Ave., Kansas City, Mo. (*Jun., Feb. 28, 1899; Assoc. M., June 6, 1906*)	April 6, 1909
Taylor, Hugh McGehee. Asst. Gen. Mgr., National Railways of Mexico, City of Mexico, Mexico	July 1, 1909
Taylor, James Townsend. Cons. Hydr. Engr., Honolulu, Hawaii	Jan. 3, 1894

MEMBERS T

	Date of Membership
Taylor, Lucian Arnold. Cons. Engr., 619 Tremont Bldg., Boston, Mass.	Nov. 4, 1891
Taylor, Samuel Alfred. Cons. Civ. and Min. Engr., 804 Lewis Blk., Pittsburg, Pa	Oct. 7, 1903
Taylor, Thomas Ulvan. Prof. of Civ. Eng., Univ. of Texas, Austin, Tex. (*Assoc., Jan. 31, 1893; Assoc. M., Oct. 2, 1895*)	Oct. 2, 1901
Taylor, William Dana. Chf. Engr., T., St. L. & W. R. R., C. & A. R. R., Minn. & St. L. R. R., and Iowa Cent. Ry., 900 Railway Exchange, Chicago, Ill	Mar. 1, 1899
Taylor, William Gavin. Deputy Chf. Engr., Passaic Val. Sewerage Commrs., 92 Park Pl., Newark, N. J	June 5, 1907
Tays, Eugene Augustus Hoffman. Min. Engr., San Blas, Distrito de Fuerte, Sinaloa, Mexico (*via* Nogales, Ariz.)	April 6, 1898
Teichman, Frank. Designing Engr., U. S. Reclamation Service, Phœnix, Ariz.	Oct. 5, 1904
Teilman, Ingvart. Mgr. and Chf. Engr., Fresno & Consolidated Canal Companies, Fresno, Cal	June 3, 1903
Temple, Edward Brinton. Asst. Chf. Engr., P. R. R. Co., Broad St. Station, Philadelphia, Pa	Oct. 2, 1907
Temple, John Charles. Care, S. Morgan Smith, 644 Am. Trust Bldg., Chicago, Ill	May 4, 1898
Temple, William Henry Giles. Civ. and Hydr. Engr., 75 Westminster St., Providence, R. I	Feb. 3, 1892
Tenney, Willis Robinson. Room 21, Municipal Bldg., Brooklyn, N. Y.	May 4, 1909
Terrell, Williford Harry. Cons. Civ. and Hydr. Engr., Clyde, N. C. (*Assoc. M., Nov. 1, 1905*)	Dec. 3, 1907
Terry, John Hermon. Secy. and Treas., Latta & Terry Constr. Co., 1319 Penna. Bldg., Philadelphia, Pa	Oct. 2, 1907
Thacher, Edwin. Cons. Engr. and Member, Concrete-Steel Eng. Co., Park Row Bldg., New York City	Feb. 17, 1869
Thackray, George Edward. Structural Engr., Cambria Steel Co., Johnstown, Pa. (*Jun., Sept. 6, 1882*)	April 7, 1886
Thayer, Russell. United Gas Impvt. Co., Philadelphia, Pa	Dec. 6, 1882
Thian, Prosper Eugene. Asst. Engr., N. P. Ry Co., Mandan, N. Dak.	Nov. 7, 1906
N. Thomas, Benjamin Franklin. U. S. Prin. Asst. Engr., 415 Custom House, Cincinnati, Ohio	April 6, 1887
Thomas, Chester Ashley. Res. Mgr., Yukon Gold Co., Dawson, Y. T., Canada	Nov. 8, 1909
Thomas, David Gorton. The Denver Union Water Co., Denver, Colo.	June 1, 1909
Thompson, Arthur Webster. Chf. Engr., M. of W., B. & O. R. R. Co., B. & O. Bldg., Baltimore, Md. (*Assoc. M., June 4, 1902*)	April 5, 1910
Thompson, Benjamin. Cons. and Contr. Engr., 224 Am. National Bank Bldg., Tampa, Fla	July 3, 1889
Thompson, Ellis Dunn. Cons. Engr., Real Estate Trust Bldg., Philadelphia, Pa	Feb. 1, 1899
Thompson, Fred. Civ. Engr., U. S. N., U. S. Naval Coal Depot, Tiburon, Cal	Oct. 1, 1902
Thompson, Gaylord. Chf. Engr., Ohio Elec. Ry. Co., Springfield, Ohio	April 2, 1890
Thompson, Henry Clark. Div. Engr., N. Y. C. & H. R. R. R., West 42d St. Ferry, New York City	Feb. 4, 1903
Thompson, Robert Andrew. Chf. Engr., Wichita Falls & Northwestern Ry., Wichita Falls, Tex. (*Jun., April 6, 1897; Assoc. M., Oct. 4, 1899*)	Jan. 3, 1911
THOMPSON, SAMUEL CLARENCE. (*Director*). Engr. of Highways, Borough of the Bronx, 177th St., and 3d Ave., New York City	Feb. 6, 1889
Thompson, Sanford Eleazer. Cons. Engr., Newton Highlands, Mass. (*Assoc. M., April 1, 1896*)	May 1, 1906
Thompson, Wilford Ashford. First Asst. City Engr.; Vice-Pres., East St. Louis Eng. Co., Cahokia Bldg. (Res., 1802 College Ave.), East St. Louis, Ill. (*Jun., Oct. 1, 1901; Assoc. M., Oct. 4, 1905*)	Nov. 30, 1909
Thompson, William Andrew. U. S. Asst. Engr., Upper Mississippi River Impvt., La Crosse, Wis	Oct. 7, 1896
Thomson, Ernest Burslem. U. S. Asst. Engr., U. S. Engr. Office, 321 Custom House, Portland, Ore. (*Assoc. M., June 5, 1901*)	May 31, 1904
Thomson, John. 253 Broadway, New York City	Mar. 2, 1887
Thomson, Reginald Heber. City Engr. (Res., 955 Thirteenth Ave., N.), Seattle, Wash	Dec. 2, 1903
Thomson, Thomas Kennard. Cons. Engr., 50 Church St., New York City. (*Jun., Oct. 3, 1888; Assoc. M., June 3, 1891*)	Dec. 4, 1895
Thornley, Julian. The Ansonia, 74th St. and Broadway, New York City. (*Assoc. M., Jan. 2, 1901*)	Sept. 5, 1905
Thornton, Charles James. Care, Jamaica Govt. Ry., Kingston, Jamaica	Sept. 6, 1910
Tibbals, George Attwater. Secy. and Treas., The Continental Iron Works, Brooklyn, N. Y. (*Jun., May 2, 1888*)	Mar. 4, 1896
Tibbals, Samuel Gaylord. The Continental Iron Works, Brooklyn, N. Y. (*Jun., May 2, 1888*)	May 5, 1897
Tighe, James Lawrence. City Engr., and Engr., Holyoke Water-Works, Holyoke, Mass. (*Assoc. M., Oct. 5, 1898*)	May 31, 1904

	Date of Membership
Tillson, George William. Chf. Engr. in Chg. of Bureau of Highways, Borough of Manhattan, New York City (Res., 93 Lenox Rd., Brooklyn, N. Y.)	Oct. 7, 1896
Timonoff, Vsevolod Evguenievitch. Director, Statistical Dept., Ministry of Ways of Communications; Prof., Inst. of Ways of Communications; Member of the Technical Counsels, Minstry of Commerce and Industry, Ministry of Ways of Communications; President of Hydrological Committee, Ministry of Agriculture, F 2 Perspective Zagorodny, St. Petersburg, Russia	May 3, 1893
Tingley, Richard Hoadley. 50 Church St., New York City	April 3, 1901
Tinker, George Henry. Bridge Engr., N. Y., C. & St. L. R. R., Hickox, Bldg., Cleveland, Ohio	Aug. 31, 1909
Tinkham, Samuel Everett. Asst. Engr., Eng. Dept., City Hall, Boston, Mass	Mar. 2, 1892
Tintorer y Giberga, Joseph. Claris 32, Barcelona, Spain	May 5, 1880
Tittmann, Otto Hilgard. U. S. Coast and Geodetic Survey, Washington, D. C	June 4, 1902
Todd, Alexander Miller. U. S. Asst. Engr., P. O. Box 404, Vicksburg, Miss. *(Jun., Oct. 1, 1895; Assoc. M., Oct. 2, 1901)*	June 6, 1905
Todd, Frank Herbert. City Engr., Box 868, El Paso, Tex	Feb. 6, 1889
Tollinger, Edward Chandler. U. S. Asst. Engr., P. O. Box 404, Vicksburg, Miss	June 4, 1902
Tomlinson, Alfred Thomas. Dist. Engr., Grand Trunk Pacific, Districts C and D. N. T. C., Cochrane, Ont., Canada	Sept. 7, 1887
Tomlinson, Sam. N. High St., Singapore, Straits Settlements	April 6, 1892
Tompkins, Edward De Voe. Cons. and Const. Engr., 81 East 125th St., New York City. *(Jun., Feb. 2, 1897; Assoc. M., Dec. 3, 1902)*	May 1, 1906
Tompson, George Morris. Cons. Engr., Parker Rd., Wakefield, Mass	May 2, 1888
Tone, Sumner La Rue. Second Vice-Pres., Pittsburg Rys. Co., Allegheny County Light Co., 435 Sixth Ave., Pittsburg, Pa	Dec. 4, 1901
Tonkin Thomas, Juan. Care, Bank of Chili, Santiago, Chili. *(Assoc. M., Mar. 7, 1900)*	Jan. 7, 1908
Tönnesen, Tobias. Gen. Representative and Engr.-in-Chf., South West Africa Co., Ltd., Grootfontein, German S. W. Africa	May 1, 1901
Torrance, William Martin. Cons. Engr. (Torrance & Taylor), 39 Cortlandt St., New York City	July 1, 1909
Touceda, Enrique Augusto. Prof., Metallurgy, Rens. Poly. Inst.; Chemist and Metallurgist, Broadway, Cor. Thacher St., Albany, N. Y	Jan. 3, 1900
Tower, Morton Loudon. U. S. Asst. Engr., U. S. Engr. Office, 665 Monadnock Bldg., San Francisco, Cal. *(Assoc. M., May 6, 1908)*	July 1, 1909
Towl, Forrest Milton. Cons. Engr., 26 Broadway, New York City (Res., 749 Carroll St., Brooklyn, N. Y.)	Feb. 5, 1896
Towle, Stevenson. Cons. Engr., 17 West 90th St., New York City	Feb. 19, 1868
Townsend, Curtis McDonald. Col. Corps of Engrs., U. S. A., Jones Bldg., Detroit, Mich	Nov. 1, 1893
Trask, Frank Ellsworth. Cons. Civ. and Hydr. Engr., 421 Homer Laughlin Bldg., Los Angeles, Cal. *(Assoc. M., June 5, 1895)*	Jan. 2, 1901
Treadwell, Lee. Vice-Pres. and Chf. Engr., Union Bridge & Constr. Co., 903 Sharp Bldg., Kansas City, Mo. *(Jun., Nov. 5, 1890; Assoc. M., Oct. 4, 1893)*	Dec. 2, 1896
Tretter, Gustav Adolph. Erection Mgr., Virginia Bridge & Iron Co., Roanoke, Va	April 6, 1904
Tribus, Louis Lincoln. Cons. Engr. and Acting Commr. of Public Works, Borough of Richmond, New York City; Civ. and Hydr. Engr. (Tribus & Massa), 86 Warren St., New York City. *(Jun., April 4, 1888; Assoc. M., June 1, 1892)*	April 1, 1896
Triest, Wolfgang Gustav. Vice-Pres., The Snare & Triest Co., 143 Liberty St., New York City. *(Jun., Sept. 3, 1890; Assoc., Mar. 6, 1900)*	Jan. 31, 1905
Tripp, Oscar Holmes. Room 30, Court House, Rockland, Me. *(Assoc. M., Oct. 7, 1896)*	Sept. 5, 1905
Trocon, Albert Alexander. (The Midland Bridge Co., Freygang & Trocon, Proprs.), Kansas City, Mo	May 1, 1895
Trotter, Alfred Williams. 141 Broadway, New York City. *(Jun., Sept. 5, 1883)*	Nov. 7, 1894
Trout, Charles Eliphalet. Asst. Engr., Dept. of Docks and Ferries, Pier A, North River, New York City. *(Jun., Oct. 31, 1899; Assoc. M., Jan. 8, 1902)*	Oct. 30, 1906
Trumbull, Morris Kinnard. Prin. Asst. Engr., Chic. & W. Indiana R. R. Co., Room 67, Dearborn Station, Chicago, Ill	April 5, 1910
Trundle, Horatio Hartley. Civ. Engr. and Contr., Leesburg, Loudoun Co., Va. *(Assoc. M., June 7, 1899)*	Mar. 6, 1901
Tsuji, Taro. Engr., Imperial Govt. Rys., Hongo Yumicho Nichome 24, Tokyo, Japan. *(Jun., Oct. 8, 1891; Assoc. M., Oct. 4, 1899)*	Mar. 1, 1904
Tucker, Edward Austin. Structural Engr., 683 Atlantic Ave., Boston, Mass	June 6, 1906

	Date of Membership
Tucker, Lester Waldo. With Westinghouse, Church, Kerr & Co., 10 Bridge St., New York City	Dec. 4, 1901
Tucker, Ross Francis. Pres., Concrete Products Co., 35 West 32d St., Room 1103, New York City	Oct. 7, 1903
Tucker, William Conquest. 156 Fifth Ave., New York City. (*Jun., May 5, 1891; Assoc. M., Dec. 5, 1894*)	Jan. 3, 1905
Tuckey, Thomas William Townsend. Engr.-in-Chf., Tientsin-Pukow Ry., Nanking, China	June 3, 1903
Turner, Claude Allen Porter. Cons. Engr., 816 Phœnix Bldg., Minneapolis, Minn	Mar. 6, 1901
Turner, Daniel Lawrence. Gen. Insp. of Stations, Public Service Comm. for the First Dist., 220 West 107th St., New York City. (*Assoc. M., Feb. 2, 1898*)	Jan. 3, 1905
Turner, Edmund Kimball. 53 State St., Boston, Mass	Nov. 4, 1891
Turner, Nathaniel. 228 Calle de Hidalgo, Monterey, Mexico	Mar. 6, 1895
Turner, Orville Hickman Browning. Chf. Engr., St. Louis, Rocky Mt. & Pac. Ry. Co., Raton, N. Mex	Feb. 2, 1909
Tuska, Gustave Robitscher. Cons. Engr., 68 William St., New York City. (*Jun., Mar. 6, 1894; Assoc. M., Jan. 1, 1896*)	Nov. 2, 1900
Tutein-Nolthenius, Rudolph Peter Johann. No. 98 Nieuwe Plantage, Delft, The Netherlands	Dec. 6, 1899
Tuthill, Job. Asst. Engr., Cin., Hamilton & Dayton Ry., Cincinnati, Ohio. (*Jun., June 6, 1888*)	Oct. 4, 1893
Tuttle, Arthur Smith. Engr. in Chg., Div. of Public Impvts., Board of Estimate and Apportionment, 277 Broadway, New York City. (*Jun., Mar. 2, 1887; Assoc. M., May 2, 1894*)	Mar. 2, 1898
Tutwiler, Thomas Henry. Pres. and Gen. Mgr., The Memphis St. Ry. Co., Memphis, Tenn	June 4, 1902
Tye, William Francis. Pres., Sterling Coal Co., 7 King St., East, Toronto, Ont., Canada	Sept. 1, 1897
Tyler, William Dowlin. Chf. Engr., Clinchfield Coal Corporation, Dante, Va	Nov. 30, 1909
Tyson, Anderson Harvey. 140th St. and East River, New York City	Oct. 2, 1889
Ubsdell, John Arnold, Jr. Gen. Supt., Great Lakes Eng. Works (Res., 294 West Grand Boulevard), Detroit, Mich	June 3, 1908
Uhler, William David. Second Asst. Engr., State Roads Comm., Care, Johns Hopkins Univ., Baltimore, Md. (*Assoc. M., May 6, 1908*)	Mar. 1, 1910
Uhlig, Carl. Asst. Engr., Board of State Harbor Commrs., Ferry Bldg., San Francisco, Cal	Oct. 7, 1903
Ulrich, John Clarence. Civ. and Hydr. Engr., Denver, Colo	Mar. 4, 1908
Upham, Charles Clifton. Vice-Pres. and Gen. Mgr., New York Steam Co., 140 Cedar St., New York City	April 7, 1897
Vail, Charles Davis. (Vail, Walbron & Read), 1220 First National Bank Bldg., Denver, Colo. (*Assoc. M., June 6, 1900*)	Aug. 31, 1909
Value, Beverly Reid. Empire Eng. Corporation, 60 Wall St., New York City	Jan. 2, 1901
Van Alstyne, Henry Arthur. 149 Echo Ave., New Rochelle, N. Y. (*Assoc. M., June 6. 1900*)	Dec. 3, 1907
Van Buren, John D. New Brighton, Borough of Richmond, N. Y	May 20, 1868
Van Buren, Robert. 58 West Ave., Norwalk, Conn	June 17, 1868
Van Cleve, Aaron Howell. Head Engr., City of London, London, Ont., Canada. (*Jun., May 31, 1892; Assoc. M., Dec. 5, 1894*)	Nov. 1, 1904
Vandevanter, Charles Oscar. Cons. Engr., Leesburg, Va	Sept. 2, 1896
Van Frank, Phillip Riley, Jr. Care, U. S. Engr. Office, Little Rock, Ark.	Aug. 31, 1909
Van Hoesen, Edmund French. Expert on Railroad Crossings, Barge Canal, Albany, N. Y	July 1, 1891
Van Horne, John Garret. 165 Broadway, Room 2611, New York City	Feb. 4, 1880
Van Keuren, Charles Augustus. Chf. Engr., Board of Street and Water Commrs., Jersey City, N. J	May 3, 1905
Van Norden, Ernest Maitland. Civ. Engr., New York Edison Co., 55 Duane St., New York City (Res., 1419 Pacific St., Brooklyn, N. Y.). (*Assoc. M., May 6, 1903*)	Oct. 2, 1906
Van Norden, Rudolph Warner. Cons. Engr., 407 Union Trust Bldg., San Francisco, Cal	July 1, 1909
Van Orden, Charles Hopkins. Catskill, N. Y	June 1, 1898
Van Ornum, John Lane. Prof. of Civ. Eng., Washington Univ., St. Louis, Mo. (*Assoc. M., Oct. 3, 1894*)	Oct. 4, 1899
Van Sant, Robert Lawrence. Contr. Engr., 421 Olive St., St. Louis, Mo.	Sept. 3, 1884
Van Vleck, John. 100 Broadway, New York City	May 3, 1905
Van Winkle, Edgar Beach. 115 East 70th St., New York City	Dec. 2, 1868
Van Winkle, Edward. Cons. Patent Engr., The West St. Bldg., New York City	Nov. 30, 1909

	Date of Membership
Vaughan, Charles Herbert. Chf. Engr., Penn Bridge Co., 3409 Fifth Ave., Beaver Falls, Pa.	May 2, 1906
Vaughan, George Washington. Engr., M. of W., N. Y. C. & H. R. R. R. Co., Grand Central Palace, New York City. (*Jun., Mar. 3, 1886*)	Nov. 4, 1896
Vaughan, Louis Bertrand. 172 Downs St., Kingston, N. Y.	Jan. 31, 1911
Vaughn, George Washington. Leavenworth, Kans.	June 3, 1891
Venable, William Mayo. Mgr., Breakwater Co. (Res., 216 Woodbine St.), Louisville, Ky. (*Assoc. M., Sept. 4, 1901*)	Oct. 1, 1907
Vent, Frederick Goodman. Asst. Engr., C., B. & Q. R. R., 209 Adams St., Chicago, Ill.	May 3, 1910
Verrill, George Elliot. U. S. Asst. Engr., 407 First National Bank Bldg., New Haven, Conn.	Mar. 2, 1904
Veuve, Erle Leroy. Cons. Engr., 693 Pacific Electric Bldg., Los Angeles, Cal. (*Jun., Sept. 3, 1901*)	Feb. 2, 1909
Vielé, Maurice Augustus. 49 Wall St., New York City. (*Jun., Feb. 4, 1891; Assoc. M., Sept. 7, 1892*)	Oct. 6, 1897
Vincent, Edward Franklin. Asst. Chf. Engr., Colo. & South. Ry. Co., 805 Cooper Blk., Denver, Colo.	Aug. 31, 1909
Vincent, Edwin Derickson. Asst. Chf. Engr., Bureau of Harbor Impvt., City Hall, Los Angeles, Cal.	May 4, 1909
Vincent, James Irving. Asst. Engr., The Scherzer Rolling Lift Bridge Co. of Chicago, 220 Broadway, New York City	June 30, 1910
Vogleson, John Albert. 1317 Spruce St., Philadelphia, Pa. (*Assoc. M., Jan. 2, 1901*)	Mar. 31, 1908
von Emperger, Fritz Edler. K. K. Oberbaurat; Rat im K. K. Patentamt; Herausgeber von *Beton und Eisen*, Vienna IV, Austria	Feb. 5, 1908
von Geldern, Otto. Cons. Engr., 865 Pacific Bldg., San Francisco, Cal.	May 4, 1892
von Leer, Isaac Wayne. Civ. and Min. Engr., 1520 Chestnut St., Philadelphia, Pa.	May 3, 1899
von Schon, Hans August Evald Conrad. Cons. Engr., 603 Wayne County Bank Bldg., Detroit, Mich.	Sept. 2, 1902
Voorhees, Theodore. Vice-Pres., P. & R. Ry. Co., Reading Terminal, Philadelphia, Pa.	May 6, 1885
Vorce, Clarence Browning. Chf. Engr., British Columbia Elec. Ry. Co., Ltd., Vancouver, B. C., Canada. (*Jun., April 30, 1895; Assoc. M., Oct. 7, 1896*)	May 2, 1900
Vose, Richard Hampton. Colima, Colima, Mexico	Oct. 7, 1908
Vredenburgh, Watson, Jr. Cons. and Insp. Engr. (Hildreth & Co.), 135 Broadway, New York City. (*Assoc. M., May 6, 1901*)	Mar. 1, 1910
Waddell, Charles Edward. 78 Patten Ave., Asheville (Res., Biltmore), N. C.	Mar. 1, 1910
Waddell, John Alexander Low. (Waddell & Harrington, Cons. Engrs.), 1012 Baltimore Ave., Kansas City, Mo.	Oct. 5, 1881
Waddell, Montgomery. Cons. Engr., 1 West 101st St., New York City. (*Jun., Sept. 1, 1886*)	Sept. 2, 1896
Waddell, Robert William. 3212 Central St., Kansas City, Mo.	Sept. 4, 1901
Wadsworth, George Reed. Asst. to the Pres., The Peerless Motor Car Co., Cleveland, Ohio. (*Assoc. M., Nov. 7, 1906*)	Nov. 8, 1909
Wadsworth, Henry Hayes. 804 Chronicle Bldg., San Francisco, Cal.	Oct. 2, 1901
Wadsworth, Joel Edward. Res. Engr., Am. Bridge Co., 30 Church St., New York City. (*Jun., Dec. 5, 1893; Assoc. M., May 5, 1897*)	June 6, 1905
Wagner, Bernard Matthew. Engr. in Chg., Watershed Div., Dept. of Water Supply, Gas and Electricity, Rockville Center, N. Y. (*Assoc. M., May 3, 1899*)	Dec. 1, 1903
Wagner, Fred J. Chf. Engr., Scott Bros., P. O. Box 403, Rome, N. Y. (*Assoc. M., April 4, 1906*)	Sept. 6, 1910
Wagner, Joseph Christian. Surv. and Regulator, 8th Survey Dist., Dept. of Public Works, Philadelphia, National Bank Bldg., Germantown (Res., 1539 North 12th St.), Philadelphia, Pa. (*Assoc. M., June 7, 1899*)	June 5, 1906
Wagner, Samuel Tobias. Asst. Engr., P. & R. Ry., Huntingdon St. Station, Philadelphia, Pa.	Feb. 2, 1887
Wagoner, Luther. Cons. Engr., 910 Pacific Bldg., San Francisco, Cal.	May 2, 1906
Wait, John Cassan. Attorney at Law, Eng. Jurisprudence, 38 Park Row, New York City	Feb. 3, 1892
Waite, Guy Bennett. Mgr., Standard Concrete Steel Co., 31st-32d Sts., East River, New York City. (*Assoc. M., May 2, 1894*)	Nov. 5, 1907
Waldo, Mark Albigence. Care, The Dominion Phosphate Co., Bartow, Fla.	May 2, 1900
Waldron, Samuel Payson. Care, Am. Bridge Co., 30 Church St., New York City. (*Assoc. M., Jan. 7, 1903*)	May 4, 1909
Walker, Clement Isaac. Chf. Engr., Empire City Subway Co. (Ltd.), 426 West 58th St., New York City. (*Assoc. M., April 1, 1891*)	May 3, 1904
Walker, Elton David. Prof. of Hydr. and San. Eng., The Pennsylvania State Coll., and Cons. Engr., State College, Pa. (*Jun., Oct. 4, 1892; Assoc. M., June 1, 1898*)	Sept. 5, 1900

		Date of Membership
	Walker, Emery Lafayette. Eastern Mgr., Pacific Coast Condensed Milk Co., Berlin, Wis	May 3, 1910
	Walker, Frank Hiram. Ashland, Ore	Aug. 31, 1909
	Walker, James Wilson Grimes. Civ. Engr., U. S. N., Naval Training Station, Newport, R. I	Oct. 5, 1904
	Walker, Jesse Wager. (Pittsburg Constr. Co.), Diamond National Bank Bldg., Pittsburg, Pa	May 7, 1884
	Walker, John Simpson. U. S. Asst. Engr., Nashville, Tenn	Jan. 5, 1881
	Walker, Meriwether Lewis. Maj., Corps of Engrs., U. S. A., Fort Leavenworth, Kans	Feb. 2, 1909
R.	Wall, Edward Everett. Asst. Water Commr., Room 312, City Hall, St. Louis, Mo	Feb. 1, 1905
	Wallace, Harold Ulmer. Cons. Engr., Marquette Bldg., Chicago, Ill	Dec. 7, 1904
R.	**WALLACE, JOHN FINDLEY.** *(Past-President)*. Pres., Electric Properties Co., 165 Broadway, New York City	June 2, 1886
	Wallace, John Herbert. Cons. Engr., 2414 Gough St., San Francisco, Cal.	Jan. 2, 1890
	Wallace, Joseph Harrison. Temple Court Bldg. (Res., 604 West 115th St.), New York City. *(Jun., Dec. 1, 1896; Assoc. M., Dec. 1, 1897)*	Nov. 6, 1901
	Walmsley, Walter Newbold. Care, São Paulo Tramway, Light & Power Co., Ltd., São Paulo, Brazil	Dec. 1, 1908
	Walsh, George Scherzer. Room 308, Richard Blk., Lincoln, Nebr. *(Jun., Feb. 2, 1897; Assoc. M., May 1, 1901)*	Mar. 31, 1908
	Walter, Raymond F. Superv. Engr., U. S. Reclamation Service, 519 Commonwealth Bldg., Denver, Colo	Oct. 5, 1909
	Ward, Charles Dod. 702 St. Nicholas Ave., New York City	Mar. 3, 1869
	Ward, Thomas Monroe. Chf. Engr. and Gen. Mgr., Canton R. R., and Md. & Penn. R. R., 24 Commerce St., Baltimore, Md	Mar. 7, 1906
	Wardle, Edward Beaumont. Engr. for Geo. F. Hardy, 309 Broadway, Room 608, New York City. *(Assoc. M., Dec. 4, 1907)*	May 31, 1910
	Warner, Edwin Hall. 329 San Fernando Bldg., Los Angeles, Cal. *(Assoc. M., May 6, 1891)*	Oct. 4, 1893
	Warner, Frank Charles. U. S. Asst. Engr., Delaware City, Del	Dec. 6, 1905
	Warren, William Henry. Challis Prof. of Eng., Univ. of Sydney, Sydney, New South Wales, Australia	Feb. 5, 1890
	Warrington, Harry Esmond. 1486 West 8th St., Riverdale, Cal. *(Assoc. M., April 6, 1898)*	Mar. 5, 1907
	Washburn, Delos Cuyler. Aberdeen, S. Dak	May 3, 1910
	Washburn, Frank Sherman. 413 Keyser Bldg., Baltimore, Md	Nov. 7, 1888
	Wason, Leonard Chase. Pres. and Engr., Aberthaw Constr. Co., 8 Beacon St., Boston, Mass. *(Assoc. M., April 3, 1901)*	April 1, 1903
	Waterhouse, John. 237 West 142d St., New York City	Oct. 4, 1899
	Wathen, Benjamin Southern. Chf. Engr., Tex. & Pac. Ry., Dallas, Tex.	Nov. 2, 1892
	Watkins, Frederick William. Div. Engr., Jerome Park Reservoir Div., Dept., Water Supply, Gas and Electricity, New York City; Res., 45 Rockledge Ave., White Plains, N. Y	Oct. 3, 1883
	Watkins, Richard. "Lynwood," Marrickville Rd., Marrickville, near Sydney, New South Wales, Australia	Dec. 3, 1890
	Watson, Irvine. Engr., U. S. Reclamation Service, Sunnyside, Wash. *(Assoc. M., June 3, 1903)*	Mar. 3, 1908
	Watson, Wilbur Jay. 1328 Citizens Bldg., Cleveland, Ohio. *(Jun., Oct. 4, 1898; Assoc. M., Jan. 2, 1901)*	Jan. 3, 1905
	Watson, William. Secy., Am. Acad. of Arts and Sciences, 107 Marlborough St., Boston, Mass. *(Assoc. Mar. 1, 1882)*	Sept. 2, 1891
	Watt, David Alexander. Superv. Engr., N. Y. State Barge Canal, Albany, N. Y	Feb. 6, 1901
	Watt, John Marshall Gilkison. Asst. Div. Engr., Corozal, Canal Zone, Panama	Feb. 5, 1902
	Wauters, Carlos. Avenida de Mayo 878, Buenos Aires, Argentine Republic.	Oct. 5, 1909
	Webb, De Witt Clinton. Civ. Engr., U. S. N., Navy Yard, Boston, Mass.	Sept. 6, 1905
	Webb, George Herbert. Chf. Engr., Mich. Cent. R. R., Detroit, Mich	Feb. 1, 1893
	Webb, Walter Loring. Chf. Civ. Engr., Dodge, Day & Zimmermann, 608 Chestnut St., Philadelphia, Pa. *(Assoc. M., May 4, 1892)*	May 3, 1904
	Weber, Alexander Hamilton. U. S. Asst. Engr., Colorado Bldg., Washington, D. C	Oct. 3, 1900
	Webster, Albert Lowry. Cons. Engr., 82 Wall St., New York City. *(Jun., Sept. 6, 1882; Assoc. M., June 3, 1891)*	April 6, 1909
	Webster, Charles Edward. Cons. Engr., South Bethlehem, Pa	Oct. 4, 1899
	Webster, George Smedley. Chf. Engr. and Surv., Bureau of Surveys, City Hall, Philadelphia, Pa. *(Assoc. M., Sept. 7, 1892)*	Oct. 4, 1893
	Webster, William Richardson. Cons. and Insp. Engr., 411 Walnut St., Philadelphia, Pa	April 5, 1899
	Weedin, Kirby Calhoun. Constr. Supt., J. G. White & Co., Inc., 43 Exchange Pl., New York City	April 5, 1910
	Weeks, William Charles. Contr. Engr., 14 Burns Blk., Vancouver, B. C., Canada	Oct. 2, 1907
	Wegmann, Edward. Cons. Engr., Dept. of Water Supply, Gas and Electricity, 13 Park Row, Room 2520, New York City	Mar. 7, 1888

	Date of Membership
Weidman, William Roe. 369 Williams Ave., Portland, Ore.	Feb. 1, 1910
Weiskopf, Samuel C. Cons. Engr., 68 William St., New York City. (*Jun., May 7, 1884*)	Dec. 5, 1888
Wells, Charles Edwin. Div. Engr., Board of Water Supply, City of New York, Kimball Ave., Yonkers, N. Y.	June 1, 1892
Wells, George Miller. Office Engr., Atlantic Div., Gatun, Canal Zone, Panama. (*Assoc. M., Oct. 3, 1906*)	Jan. 3, 1911
Wells, James Hollis. Civ. Engr. and Archt., 32 Nassau St., New York City	Feb. 5, 1901
Wells, Lawrence William. Asst. to Gen. Mgr. and Chf. Engr., Tex. Midland R. R., Terrell, Tex.	Dec. 5, 1906
Wendt, Edwin Frederick. Asst. Engr., Pitts. & Lake Erie R. R. Co., Terminal Bldg., Pittsburg, Pa.	Oct. 7, 1903
Wentworth, Charles Chancellor. Prin. Asst. Engr., Norfolk & West. Ry., Roanoke, Va.	April 4, 1888
Wenzell, Andrew Jackson. Cons. Engr., 107 West Hancock, Detroit, Mich.	Oct. 3, 1906
West, Charles Hunter. Member, Mississippi River Comm., Greenville, Miss.	Oct. 1, 1902
Westcott, Frank Thomas. North Attleborough, Mass.	Jan. 3, 1911
Westinghouse, George. Pittsburg, Pa.	Jan. 7, 1891
Weston, Charles Valentine. Pres., South Side Elev. R. R. Co., 935 East 49th St., Chicago, Ill.	Sept. 5, 1900
Weston, Edmund Brownell. Cons. Engr.; Pres., Jewell Export Filter Co., 86 Weybosset St., Providence, R. I.	Dec. 6, 1882
Weston, George. Asst. Chf. Engr., Board of Superv. Engrs., Chicago Traction, 181 La Salle St., Chicago, Ill.	June 5, 1907
Wetherbee, George Albert. Inglewood, Cal.	April 5, 1893
Wetherill, William Chattin. Cons. Engr., The Empire Zinc Co., 703 Symes Bldg., Denver, Colo.	Dec. 1, 1886
Weymouth, Frank Elwin. Superv. Engr., U. S. Reclamation Service, Boise, Idaho. (*Assoc. M., Sept. 4, 1901*)	Feb. 5, 1907
Wheeler, Bertrand Thorp. Engr. of Constr., N. Y., N. H. & H. R. R., 440 South Station, Boston, Mass.	June 30, 1910
Wheeler, Daniel Merrick. Railroad Insp., Mass. R. R. Comm., 230 Forest Park Ave., Springfield, Mass.	Mar. 6, 1901
Wheeler, Ebenezer Smith. U. S. Asst. Engr., Detroit, Mich.	Nov. 7, 1883
Wheeler, Edgar True. Engr., Mercereau Bridge & Constr. Co., 661 Pacific Electric Bldg., Los Angeles, Cal.	Dec. 7, 1904
Wheeler, Harry Roberts. Engr.-in-Chg. and Secy., Henry Steers, Inc., 17 Battery Pl., New York City. (*Jun., April 4, 1888; Assoc. M., May 4, 1892*)	Mar. 1, 1910
Wheeler, Levi Lockwood. Asst. U. S. Engr., Sterling, Ill.	June 4, 1884
Wheeler, William. Cons. Engr., 14 Beacon St., Boston, Mass.	Oct. 4, 1893
Wheelock, De Forest Augustus. Civ. and San. Engr., City Bldg., Warren, Pa. (*Assoc. M., Feb. 3, 1897*)	April 30, 1907
Whildin, William Gwilym. Supt., Inside Div., Lehigh Coal & Nav. Co., Lansford, Pa.	May 6, 1908
Whinery, Samuel. Cons. Engr., 95 Liberty St., New York City. (*Jun., April 1, 1874*)	May 4, 1881
Whipple, George Chandler. Cons. Engr., 103 Park Ave., New York City. (*Assoc. M., Sept. 6, 1899*)	Oct. 6, 1908
Whistler, John T. Civ. and Hydr. Engr., Chamber of Commerce Bldg., Portland, Ore. (*Assoc. M., Jan. 2, 1901*)	Oct. 7, 1903
White, George Howard. Asst. Engr., C., M. & St. P. Ry. (Res., 2709 Emerson Ave., South), Minneapolis, Minn.	May 2, 1883
White, Henry Fisher. 5463 East End Ave., Chicago, Ill.	Jan. 2, 1890
White, James Gilbert. Pres., J. G. White & Co., Inc., 43 Exchange Pl., New York City	Mar. 2, 1904
White, Timothy Sidney. Vice-Pres. and Cons. Engr., Penn Bridge Co., Beaver Falls, Pa.	April 3, 1889
White, Willard Olney. Cons. Civ. and Min. Engr., First National Bank Bldg., Uniontown, Pa. (*Assoc. M., April 3, 1907*)	Jan. 3, 1911
White, William MacIntire. Engr. with Am. Bridge Co., 30 Church St., New York City. (*Assoc. M., Jan. 2, 1901*)	Mar. 2, 1909
Whited, Willis. Asst. Engr., Dept. of Public Works, City Hall, Pittsburg, Pa. (*Assoc. M., Oct. 2, 1901*)	Nov. 1, 1910
Whitfield, James Edward. Min. Engr., 406 Locust St., Philadelphia, Pa.	Mar. 2, 1904
Whitford, Reid. U. S. Asst. Engr., Georgetown, S. C.	Dec. 2, 1896
Whitman, Ezra Bailey. Div. Engr., Disposal Works, Sewerage Comm., Back River Sewage Disposal Works, Colgate, Baltimore Co., Md. (*Jun., Feb. 3, 1903; Assoc. M., Feb. 7, 1906*)	June 30, 1910
Whitmer, David Heikes. Asst. Supt., Am. Pipe & Constr. Co., 112 North Broad St., Philadelphia, Pa.	May 6, 1903
Whitney, Frank Ormond. Chf. Engr., Street Laying-Out Dept., 25 Old Court House, Boston, Mass. (*Jun., May 3, 1876*)	Jan. 5, 1887
Whitney, Thomas Bryan, Jr. Engr. of Design, Hudson & Manhattan R. R. Co., 30 Church St., New York City. (*Jun., Sept. 6, 1898; Assoc. M., Feb. 6, 1907*)	April 5, 1910

		Date of Membership
	WHITTEMORE, DON JUAN. (*Past-President*). Cons. Engr., C., M. & St. P. Ry. Co., 222 Biddle St., Milwaukee, Wis. (*Hon. M., Jan. 6, 1911*)	July 10, 1872
	Whittemore, Walter Frank. 1 Newark St., Hoboken N. J. (*Jun., Mar. 6, 1889; Assoc. M., April 6, 1892*)	Oct. 31, 1905
	Whittier, Thomas Tupper. Engr. for George F. Hardy, 309 Broadway, New York City	May 31, 1910
	Wickes, Edward Dana. Cons. Engr., P. O. Box CC, Wellston, Ohio. (*Assoc. M., Dec. 3, 1902*)	Oct. 2, 1906
	Wiest, Julius Christian. Contr.; Gen. Mgr., Nicaragua R. R. and Steamer Line, Manague, Nicaragua	Feb. 5, 1902
	Wilcox, Frank. Engr. of The T. A. Gillespie Co., 800 Westinghouse Bldg., Pittsburg, Pa	Oct. 7, 1903
	Wiley, Andrew Jackson. Cons. Hydr. Engr., Boise, Idaho	Dec. 5, 1894
	Wiley, William Halsted. Scientific Publisher, 43 East 19th St., New York City	Feb. 17, 1869
R.	Wilgus, William John. 165 Broadway, New York City	April 1, 1896
	Wilkerson, Thomas Jefferson. Asst. Engr.-Bridge Designer, Bureau of Constr., Dept. of Public Works, City Hall, Pittsburg, Pa. (*Jun., April 3, 1894; Assoc. M., Jan. 5, 1898*)	Sept. 6, 1910
	Wilkes, James Knapp. Chf. Engr., Board of Public Works, New Rochelle, N. Y. (*Assoc. M., June 3, 1891*)	April 3, 1906
	WILKINS, WILLIAM GLYDE. (*Director*). (The W. G. Wilkins Co., Engrs. and Archts.), Westinghouse Bldg., Pittsburg, Pa	Dec. 4, 1889
	Wilkinson, Thomas Lee. Cons. Mech. Engr., 213 Boston Bldg., Denver, Colo	Feb. 5, 1908
	Williams, Charles Page. Project Engr., U. S. Reclamation Service, Powell, Wyo. (*Assoc. M., Oct. 2, 1901*)	Nov. 1, 1904
	Williams, Chauncey Grant. Contr., Lynchburg, Va. (*Assoc. M., Feb. 6, 1895*)	Oct. 7, 1903
	Williams, Cyrus John Richard. Engr., Lyttelton Harbour Board, Christchurch, New Zealand	Feb. 6, 1901
	Williams, David. Div. Engr., B. & M. R. R., St. Johnsbury, Vt	May 4, 1898
	Williams, Edward Gilbert. Constr. Mgr., J. G. White & Co., Inc., 43 Exchange Pl., New York City	Feb. 3, 1897
	Williams, Friend Pitts. Res. Engr., N. Y. State Barge Canal, Mechanicsville, N. Y	July 1, 1909
N.	Williams, Gardner Stewart. Civ. Engr., and Prof. of Civ., Hydr. and San. Eng., Univ. of Michigan, Room 207 New Engineering Bldg., Ann Arbor, Mich. (*Assoc. M., Oct. 2, 1895*)	Dec. 6, 1899
	Williams, John Norman Spencer. Supt., Kahului R. R. Co., Kahului, Maui, Hawaii	April 5, 1910
	Williams, Samuel Daugherty, Jr. Care, Mich. Cent. R. R., 489 Fort St., West, Detroit, Mich. (*Assoc. M., Dec. 2, 1903*)	Jan. 7, 1908
	Williams, William Fish. City Engr., S. E. Cor. Court and Orchard Sts., New Bedford, Mass	April 4, 1906
	Williamson, Francis Stuart. Cons. Engr., 84 William St., New York City	Sept. 7, 1887
	Williamson, Frank Robert. Asst. Engr., San. Dist. of Chicago, 1500 Am. Trust Bldg., Chicago, Ill	Nov. 7, 1906
	Williamson, Sydney Bacon. Div. Engr., Pacific Div., Panama Canal, Corozal, Canal Zone, Panama. (*Assoc. M., Jan. 3, 1894*)	Dec. 2, 1896
	Willis, Paul. Secy. and Engr., Kenwood Bridge Co., 4857 Madison Ave., Chicago, Ill	Oct. 2, 1901
	Willoughby, Julius Edgar. Engr. of Constr., L. & N. R. R.; Chf. Engr., Cairo & Thebes R. R., Wasioto & Black Mountain R. R., Athens & Tellies R. R., Kentucky Highlands R. R., and Chf. Engr. of Constr., Lexington & Eastern R. R., 9th and Broadway, Louisville, Ky	June 1, 1909
	Wilson, Charles Alfred. Railway Expert, 529 Burns Ave., Station R, Cincinnati, Ohio	April 1, 1891
	Wilson, Charles Beatty. Supt., Foster-Creighton-Gould Co., 33d St. and River, Louisville, Ky	Dec. 2, 1903
	Wilson, Charles Coker. 1302 Main St., Columbia, S. C	Dec. 4, 1907
	Wilson, Charles William Schrage. Wilson & English Const. Co., Gen. Contrs., New York City (Res., 14 Elm St., New Rochelle, N. Y.). (*Jun., April 5, 1892; Assoc. M., Jan. 3, 1900*)	June 6, 1905
	Wilson, Elliott Hinckley. Civ. and Min. Engr. (Receiver of the Minnie Healey Mine), Butte, Mont	Feb. 1, 1888
	Wilson, Everett Broomall. Secy. and Treas. of The Am. Bureau of Inspection and Tests, 1427 Monadnock Blk., Chicago, Ill. (*Assoc. M., Mar. 4, 1903*)	Dec. 6, 1904
	Wilson, George Leverett. Engr., M. of W., Twin City Rap. Trans. Co., Minneapolis, Minn	Feb. 5, 1890
	Wilson, Henry Felix, Jr. Birmingham, Ala. (*Assoc. M., April 2, 1902*).	May 2, 1905
	Wilson, Henry William. 1060 Drexel Bldg., Philadelphia, Pa	Sept. 6, 1876
	Wilson, Herbert Michael. Engr. in Chg., U. S. Bureau of Mines, Pittsburg, Pa. (*Jun., Sept. 5, 1883*)	Jan. 2, 1890

	Date of Membership
Wilson, Percy Hartshorne. Cons. Engr., 1330 Land Title Bldg., Philadelphia, Pa. (*Jun., Jan. 2, 1900; Assoc. M., Feb. 5, 1902*)	Oct. 5, 1909
Wilson, William Edward. Secy., Am. Section, International Waterways Comm., 328 Federal Bldg., Buffalo, N. Y. (*Jun., Jan. 6, 1903; Assoc. M., June 7, 1905*)	June 30, 1910
Wilson, Winter Lincoln. Prof. of Railroad Eng., Lehigh Univ., South Bethlehem (Res. 56 Church St., Bethlehem), Pa	May 1, 1901
Wiltsee, William Pharo. Asst. Engr., Norfolk & West. Ry. Co., Roanoke, Va. (*Assoc. M., Oct. 7, 1903*)	Mar. 1, 1910
Wimmer, Sebastian. R. F. D. No. 1, Albany, Stearns Co., Minn	Mar. 2, 1881
Windsor, Philip Brundage. Care, The Development Co. of Cuba, Ceballos, Cuba	July 1, 1909
Wing, Charles Benjamin. Prof. of Structural Eng., Stanford Univ., 345 Lincoln Ave., Palo Alto, Cal. (*Assoc. M., Nov. 4, 1896*)	Nov. 2, 1908
Wingfield, Nisbet. Cons. Engr. for Hydr., Sewerage, and Municipal Lighting Plants, Augusta, Ga	May 1, 1895
Winslow, Benjamin Emanuel. Structural Engr., 2540 North Sacramento Ave., Chicago, Ill	Oct. 2, 1907
Winsor, Frank Edward. Dept. Engr., Board of Water Supply, City of New York, Realty Bldg. (Res., 137 South Broadway), White Plains, N. Y. (*Assoc. M., Nov. 4, 1903*)	Dec. 5, 1905
Wise, Colin Reed. City Surv. and Supt., Sewers, 34 Bloomfield Ave., Passaic, N. J	April 6, 1904
Wisner, George Monroe. Chf. Engr., San. Dist. of Chicago, 1500 Am. Trust Bldg., Chicago, Ill	Feb. 4, 1903
Witmer, Francis Potts. Engr. in Chg. of Bridge Designing and Estimating, Am. Bridge Co., 30 Church St., New York City (Res., 32 Mulford St., East Orange, N. J.)	Nov. 30, 1909
Witmer, Joseph Franklin. Hydr. and San. Engr., Chapin Blk., Swan and Pearl Sts., Buffalo, N. Y	May 4, 1904
Witt, Carlton Carpenter. Engr., South Dakota, R. R. Comm., Pierre, S. Dak	April 6, 1909
Woermann, Frederick Christian. Cons. and Const. Engr., 724 Gunter Bldg., San Antonio, Tex	Dec. 6, 1910
Woermann, John William. Asst. Engr., Western Div., U. S. A., 428 Custom House, St. Louis, Mo. (*Assoc. M., May 1, 1895*)	May 7, 1902
Wolf, Julius Herman George. Pres. and Mgr., North Am. Exploration Co., The Exploration Oil Co., 1023 Mills Bldg , San Francisco, Cal. (*Assoc. M., May 7, 1902*)	April 5, 1904
Wolfe, Christian John. 525 Fifty-eighth St., Brooklyn, N. Y	Mar. 6, 1907
Wolfe, Frank Charles. 1319 Linden Ave., Baltimore, Md	Jan. 31, 1911
Wölfel, Paul Ludwig. Chf. Engr., McClintic-Marshall Constr. Co., Pittsburg, Pa. (*Jun., July 3, 1889; Assoc. M., July 1, 1891*)	Nov. 6, 1895
Wolff, Louis Peter. Cons. Engr., 204 Essex Bldg., St. Paul, Minn	June 30, 1910
Wolstenholme, Albert. 22 Bedford St., Fall River, Mass	June 6, 1906
Wolverton, Irving Mason. Vice-Pres. and Chf. Engr., The Mt. Vernon Bridge Co., Mt. Vernon, Ohio. (*Assoc. M., Dec. 4, 1895*)	Dec. 1, 1903
Wood, Alvinus Brier. Mgr. and Secy., Ore. & Southeast. R. R. Co., Cottage Grove, Ore	Sept. 6, 1905
Wood, Charles Widney. 315 Carondelet St., New Orleans, La	Oct. 7, 1908
Wood, Dethic Hewitt. Chf. Engr., Converse Bridge Co., 101 Chamberlain Ave., Chattanooga, Tenn. (*Assoc. M., Feb. 6, 1907*)	Nov. 1, 1910
Wood, Edward Nathan. 1003 Manhattan Bldg., Chicago, Ill	Dec. 5, 1906
Wood, Frederic James. Civ. Engr. with Stone & Webster, Foxboro, Mass.	Dec. 6, 1905
Wood, Henry Beecher. Asst. Engr., Harbor and Land Comm., Room 134, State House, Boston, Mass	April 3, 1895
Wood, Henry Shotwell. Room 1825, Park Row Bldg., New York City	May 1, 1907
Wood, Irving Sparrow. Asst. Engr. in Chg., Water Dept., City Engr.'s Office, City Hall, Providence, R. I. (*Jun., Mar. 5, 1890; Assoc. M., Mar. 7, 1900*)	Mar. 6, 1906
Wood, Joseph. First Vice-Pres., Penn. Lines, 909 Union Station, Pittsburg, Pa	April 1, 1874
Wood, Warren Powell. Chf. Engr., Central Idaho Development Co., Ltd., Lewiston & Southeastern Elec. Ry. Co., Ltd., Salmon River Power Co., Ltd., Elec. Ry. Townsite Co., Nezperce & Idaho R. R. Co., and Idaho & Northwestern R. R. Co., Sumner, Wash	July 10, 1907
Woodard, Silas H. (Noble & Woodard, Civ. and Cons. Engrs.), 7 East 42d St., New York City. (*Assoc. M., Jan. 2, 1901*)	Nov. 1, 1904
Woodbury, Charles Jeptha Hill. Cons. Engr., 45 Milk St., Boston, Mass.	Dec. 3, 1884
Woodman, Andrew Whitney. Care, Woodman & Moore, Civ. and Mech. Engrs., 150 Michigan Ave., Chicago, Ill	Oct. 4, 1905
Woodruff, Edward Lowrey. Supt., Office of Insp., 18th Light House Dist., San Francisco, Cal	Oct. 3, 1900
Woods, Henry Dickinson. 99 Highland St., West Newton, Mass. (*Assoc. M., Mar. 1, 1893*)	June 5, 1895
Woods, Robert Patterson. Cons. Engr., 801 Traction Bldg., Indianapolis, Ind. (*Jun., Feb. 2, 1897; Assoc. M., Mar. 7, 1900*)	April 1, 1903

MEMBERS W-Z

		Date of Membership
	WOODWORTH, ROBERT BELL. Engr., Carnegie Steel Co., 427 Carnegie Bldg., Pittsburg, Pa.	April 1, 1908
	WOOLDRIDGE, CHARLES LAWSON. Superv. Engr., The T. A. Gillespie Co., 125 South Lang Ave., Pittsburg, Pa.	Oct. 5, 1909
	WOOLLEY, ANDREW FEASTER. Supt., Empire Eng. Corporation, Sylvan Beach, N. Y.	Dec. 2, 1903
	WOOTEN, WILLIAM PRESTON. Capt., Corps of Engrs., U. S. A., West Point, N. Y. (*Assoc. M., May 31, 1905*)	Mar. 31, 1908
	WORCESTER, JOSEPH RUGGLES. Cons. Engr., 79 Milk St., Boston, Mass.	Jan. 2, 1895
	WORTHINGTON, CHARLES. Engr. and Archt., Great Neck Station, N. Y. (*Assoc. M., Dec. 1, 1897*)	Nov. 6, 1901
	WRENTMORE, CLARENCE GEORGE. Care, Bureau of Public Works, Manila, Philippine Islands. (*Assoc. M., April 5, 1905*)	Oct. 5, 1909
	WRIGHT, AUGUSTINE WASHINGTON. Cons. Engr., Pomona, Cal.	May 5, 1886
	WRIGHT, CHARLES HERBERT. Chf. Engr., Brown Hoisting Machinery Co., Cleveland, Ohio	Oct. 5, 1892
	WRIGHT, EDWARD THOMAS. 690 Pacific Electric Bldg., Los Angeles, Cal.	Feb. 3, 1886
	WRIGHT, JOHN BERTRAM. Deputy Div. Engr., Second Div., New York State Highway Comm., 8 McClellan Ave., Amsterdam, N. Y. (*Assoc. M., May 1, 1907*)	May 31, 1910
	WRIGHT, JOSEPH. Engr., U. S. Reclamation Service, Ronan, Mont. (*Assoc. M., Dec. 7, 1904*)	Aug. 31, 1909
	WRIGHT, JOSEPH BODINE. Cons. Engr. with Carreré & Hastings, Archts., New York City. (*Assoc. M., June 2, 1897*)	Jan. 31, 1905
	WRIGHT, PARKER O, JR. 422 Security Bldg., Los Angeles, Cal.	Jan. 4, 1910
	WRIGHT, WILLIS BENTON. Engr., Sewerage and Water Board, 501 City Hall, New Orleans, La.	Nov. 3, 1897
	WROTNOWSKI, ARTHUR FRANCIS. Tampico Nav. Co., Hermosillo, Sonora, Mexico	July 12, 1877
	YAMAGUCHI, JUNNOSUKE. Director of M. of W. Dept., Imperial Govt. Railways, Tokyo, Japan	Mar. 4, 1903
	YATES, PRESTON KING. Chf. Engr., Tomkins Cove Stone Co., Tomkins Cove, N. Y. (*Jun., June 6, 1883*)	April 5, 1893
	YEATMAN, CHARLES POPE. Grand View, Rhea Co., Tenn.	Feb. 2, 1887
	YEATMAN, MORGAN EDWARD. Cons. Engr., Parliament Mansions, Victoria St., London, S. W., England	May 4, 1892
	YEATMAN, POPE. Min. Engr., 165 Broadway, Room 1714 New York City.	Oct. 4, 1893
	YEREANCE, WILLIAM BURNET. Cons. Engr., 128 Broadway, New York City. (*Jun., May 3, 1892; Assoc. M., Dec. 2, 1896*)	Mar. 3, 1908
	YONGE, SAMUEL HUMPHREYS. U. S. Asst. Engr., in Chg. of Impvt., James River, Va., 28 North 9th St., Richmond, Va.	May 5, 1880
C.	YORK, HERBERT WALDO. Cons. Engr., Am. Smelting & Refining Co., 165 Broadway, New York City. (*Jun., May 2, 1888*)	June 3, 1896
	YOUNG, ROSCOE CYPRIAN. Chf. Engr., Munising Ry., Marquette & South Eastern Ry., Lake Superior & Ishpeming Ry., Marquette, Mich.	Oct. 1, 1902
	YOUNG, SAMUEL MCCAIN. (Of J. F. Coleman & Co., Engrs.), 920 Hibernia Bldg., New Orleans, La. (*Assoc. M., June 7, 1905*)	Sept. 6, 1910
	YUILLE, NATHANIEL ALSTON. Asst. Engr., U. S. Engr. Office, Box 709, Mobile, Ala. (*Assoc. M., June 6, 1906*)	Nov. 8, 1909
	ZARBELL, ELMER. Office, Chf. Engr., L. & N. R. R. Co., Louisville, Ky. (*Jun., Jan. 3, 1899; Assoc M., Feb. 7, 1900*)	May 5, 1908
	ZESIGER, ALBERT WILLIAM. Care, William H. Evers Eng. Co., The Arcade, Cleveland, Ohio	Aug. 31, 1909
	ZIESING, AUGUST. Pres., Am. Bridge Co., 115 Adams St., Room 1324, Chicago, Ill.	Oct. 5, 1898
	ZIFFER, EMANUEL A. Pres. of the Council of Adm. of the Imp. Royal Privileged Lemberg-Czernowitz-Jassy Ry. Co., I Opernring 5, Vienna, Austria	June 7, 1893
	ZINN, AARON STANTON. Res. Engr., Panama Canal, Empire, Canal Zone, Panama	Oct. 5, 1909
	ZINN, GEORGE ARTHUR. Lt.-Col., Corps of Engrs., U. S. A., Room 508, Federal Bldg., Chicago, Ill.	Feb. 3, 1904
	ZOLLINGER, LUTHER REESE. Engr., M. of W., P. R. R., Broad St. Station, Philadelphia, Pa.	Mar. 6, 1901
	ZOOK, MORRIS ALEXANDER. Cons. Engr., Room 463, Grand Central Station, Chicago, Ill. (Res., 123 East 6th St., Plainfield, N. J.)	Oct. 4, 1899

Members, 2 784.

ASSOCIATE MEMBERS

[Assoc. M. Am. Soc. C. E.]

	Date of Membership
Abbott, Hunley. Care, MacArthur Bros. Co., 11 Pine St., New York City. (*Jun., Sept. 5, 1905*)	Dec. 6, 1910
Abella, Juan. Cons. Engr., Parliament Mansions, Victoria St., Westminster, London, S. W., England	Jan. 6, 1897
Ackenheil, Alfred Curtis. Asst. Engr., T. A. Gillespie Co., 3423 Webster Ave., Pittsburg, Pa	April 6, 1909
Ackerman, Alexander Seymour. Asst. Engr., Cape Cod Constr. Co., Sandwich, Mass. (*Jun., April 30, 1907*)	April 6, 1909
Adams, Arthur. Asst. Hydr. Engr., J. G. White & Co., Inc., 43 Exchange Pl., New York City. (*Jun., Oct. 1, 1901*)	April 6, 1904
Adams, Charles Robert. Asst. Engr., U. S. Geological Survey, Old Capitol Bldg., St. Paul, Minn	Feb. 1, 1910
Adams, Edward Maguire. Capt., Corps of Engrs., U. S. A., U. S. Engr. Office, Charleston, S. C. (*Jun., Oct. 7, 1902*)	Jan. 3, 1906
Adams, Everett Eugene. Asst. to Cons. Engr., Union Pacific and Southern Pacific Systems, 135 Adams St., Chicago, Ill	April 1, 1908
Adams, Raymond Edmond. Civ. Engr., War Dept. (Res., 808 Taylor St., N. W.), Washington, D. C. (*Jun., May 1, 1900*)	Dec. 6, 1905
Addison, Charles Lambert. Asst. to Pres., Long Island R. R. Co., Long Island City, N. Y	May 1, 1907
Adey, William Henry. Asst. Engr., D. & H. Co., Albany (Res., 181 Main St., Cohoes), N. Y. (*Jun., Feb. 4, 1896*)	Dec. 3, 1902
Adgate, Frederick Whitney. Western Mgr., The Foundation Co., 419 Rookery Bldg., Chicago, Ill	Jan. 6, 1904
Aegerter, Albert August. 501 Stock Exchange Bldg., St. Louis, Mo	Mar. 1, 1910
Agramonte, Albert Arthur. Direccion de Desagües, Dolores, F. C. Sud, Buenos Aires, Argentine Republic	Oct. 7, 1908
Aikenhead, James Ray. With Westinghouse, Church, Kerr & Co., 10 Bridge St., New York City	Feb. 7, 1906
Albree, Ralph. 1112 Western Ave., Allegheny, Pa. (*Jun., Oct. 4, 1898*)	Oct. 1, 1902
Alderson, Algernon Brown. 49 Pearl St., Hartford, Conn	Oct. 2, 1907
Alderson, William Howard. Cons. Engr.'s Office, S. P. Co., Union Pacific System, 135 Adams St., Room 603, Chicago, Ill. (*Jun., Dec. 5, 1905*)	Mar. 1, 1910
Alexander, Henry James. 23 Flatbush Ave., Brooklyn, N. Y	Mar. 7, 1906
Alexander, John Howard. Chf. Engr., Hunkins-Willis L. & C. Co., St. Louis, Mo	May 4, 1909
Alexander, Kay. Chf. Engr., St. Paul Ry. Promotion Co. (St. Paul South. Elec. Ry.), 709 Metropolitan Opera House Bldg., St. Paul, Minn	Oct. 2, 1907
Alexander, Robert Lee. Asst. Engr., N. P. Ry., Chehalis, Wash. (*Jun., Nov. 1, 1904*)	Dec. 5, 1906
Allan, Alexander George. Chf. Engr., Antlers Orchard Development Co., 1340 Garfield St., Denver, Colo	Mar. 6, 1901
Allardice, Elliot Ritchie Barclay. Supt., Wachusett Dept., Met. Water-Works, Clinton, Mass	Dec. 6, 1905
Allen, Charles Metcalf. Prof. of Hydr. Eng., Worcester Poly. Inst., Worcester, Mass	June 1, 1904
Allen, Chester Salisbury. Concrete Engr., Lockwood, Greene & Co., 93 Federal St., Boston, Mass. (*Jun., Dec. 4, 1906*)	Oct. 4, 1910
Allen, Eugene Yorke. Office Engr., Railroad and Canal Revaluation, State of New Jersey, 55 Broad St., Elizabeth, N. J	Dec 6, 1905
Allen, Frank William. 7 DeKalb Ave., White Plains, N. Y. (*Jun., Nov. 3, 1896*)	May 4, 1898
Allen, Harold Dayton. With C. R. R. Co. of N. J., 27 Wakeman Ave., Newark, N. J. (*Jun., April 30, 1907*)	Dec. 6, 1910
Allen, Jean March. Care, Am. Pipe & Const. Co., Fulton, N. Y	Jan. 31, 1911
Allen, John Lee. Secy., J. L. Fulton & Co., 502 Monadnock Blk., Chicago, Ill	Nov. 1, 1905
Allen, Raymond Cleaveland. Manchester, Essex Co., Mass	Dec. 6, 1910
Allen, Robert Livingston. Care, Archbold-Brady Co., Syracuse, N. Y	May 6, 1908
Allen, Walter Henry. Municipal and San. Engr., Chehalis, Wash	Jan. 3, 1911
Allen, William Frederick. Gen. Secy. and Treas., Am. Ry. Assoc., 24 Park Pl., New York City	Jan. 3, 1900

	Date of Membership
Allison, Calvin Tomkins. Gen. Contr., Jones Bldg., Haverstraw, N. Y.	May 1, 1907
Allison, William Franklin. Prof. of Civ. Eng., Colorado School of Mines, Golden, Colo	Oct. 4, 1910
Alsberg, Julius. Care, John Bogart, 141 Broadway, New York City	June 3, 1908
Altstaetter, Frederick William. Capt., Corps of Engrs., U. S. A., Wheeling, W. Va	Nov. 6, 1907
Amburn, William Wesley. 404 Commercial Bldg., Portland, Ore	Sept. 2, 1908
Ames, George Marshall. Contr. (Hauser, Owen & Ames), 102 Ottawa St., Grand Rapids, Mich	June 7, 1899
Ammann, Othmar Hermann. Wissahickon, Philadelphia, Pa	Jan. 8, 1908
Anderberg, Edward. Asst. Engr., Barge Canal Office, Lockport, N. Y. (*Jun., Mar. 5, 1907*)	Mar. 1, 1910
Anderson, Charles Louis Bates. (Hazlehurst & Anderson, Cons. Municipal Engrs.), P. O. Box 513, Wilmington, N. C	May 6, 1908
Anderson, Robert Harlow. Res. Engr., J. G. White & Co., Inc., Parksville, Tenn	Jan. 8, 1908
Anderson, William Townsend. The Judson, Washington Sq., New York City	June 5, 1907
Andress, Harry R. 1604 South Ave., St. Louis, Mo	May 31, 1910
Angel, Floyd Dwight. Asst. Engr., U. S. Reclamation Service, Phœnix, Ariz	Oct. 4, 1910
Anthony, Walter Loring. 75 Westminster St., Providence, R. I. (*Jun., Jan. 5, 1904*)	Mar. 7, 1906
Arce, Julius Andrew. Apartado 90, Arequipa, Peru	Aug. 31, 1909
Archer, Augustus Rowley. Engr., Sales Dept., Carnegie Steel Co., Pittsburg, Pa	April 4, 1906
Arend, Albert Cornelius. Cons. Hydr., Municipal and Reinforced Concrete Engr., Brandeis Bldg., Omaha, Nebr	Feb. 2, 1909
Armitage, George Washington. Supt. of Constr., Army Transport Docks and Seawall, Fort Mason, San Francisco, Cal	April 2, 1902
Armour, Charles Webster L. Fort Smith, Ark	June 1, 1904
Armstrong, Charles Johnstone. Care, Junior Naval and Military Club, 96 Piccadilly, W., London, England	June 6, 1906
Armstrong, Robert Stuart. Engr., Brooklyn Plant, Am. Bridge Co., Ft. of Clay St., Brooklyn, N. Y	Feb. 6, 1907
Armstrong, Roger Wellington. Asst. Designing Engr., New York Board of Water Supply, 165 Broadway, New York City	Nov. 8, 1909
Arn, William Godfrey. Asst. Engr., Ill. Cent. R. R., 706 Central Station, Chicago, Ill. (*Jun., Oct. 2, 1900*)	April 6, 1909
Arnott, Robert Fleming. Cons. Engr., 95 Liberty St., New York City	Mar. 2, 1909
Ash, Dorsey. 1023 Mills Bldg., San Francisco, Cal	June 3, 1903
Atkins, Harold Bedford. Cons. Engr. and Accountant, 1409 West St. Bldg. (Res., 527 West 121st St.), New York City	April 2, 1902
Atkinson, Asher. 1 Madison Ave., New York City (Res., 49 Mine St., New Brunswick, N. J.)	April 5, 1905
Atterbury, Charles De La Plane. City Engr., Centralia, Wash	Nov. 8, 1909
Atwood, Edward Franklin. Designing Engr., Concrete Eng. Co., 101 Tremont St., Boston (Res., 90 Crest Ave., Beachmont), Mass	June 5, 1907
Atwood, Thomas Clark. Div. Engr., Board of Water Supply, 127 Franklin St., New York City (Res., 207 Woodworth Ave., Yonkers, N. Y.)	April 3, 1907
Avakian, John Caspar. Civ. and Hydr. Engr.; Pres. and Chf. Engr., Riverside Groves & Water Co., 631 Central Bldg., Los Angeles, Cal.	July 9, 1906
Averill, James Leland. Chf. Engr., Hamilton & Chambers, 29 Broadway (Res., 206 West 106th St.), New York City	Dec. 6, 1910
Awoyama, Akira. With Isthmian Canal Comm., Gatun, Canal Zone, Panama.	April 5, 1910
Ayer, Frederic Eugene. Asst. Prof., Civ. Eng., Univ. of Cincinnati, Cincinnati, Ohio	May 31, 1910
Aylett, Philip. Prin. Asst. Engr., St. Louis Municipal Bridge, 4001 Connecticut St., St. Louis, Mo	June 3, 1896
Ayres, John Henry. Supt. of Water Supply and Sewers, City Engr.'s Office, Manila, Philippine Islands	Nov. 1, 1910

Babcock, William Stuart. Civ. and Waterproofing Engr., 17 Battery Pl., New York City	Feb. 1, 1905
Babé, Joseph Manuel. Chf. Engr. of Bureau of Highways and Bridges, Dept. of Public Works, Arsenal, Havana, Cuba. (*Jun., May 31, 1904*).	Feb. 6, 1907
Backes, William James. Chf. Engr., Central New England Ry., 59 Spruce St., Hartford, Conn. (*Jun., May 31, 1904*)	July 9, 1906
Bacon, Arthur Whittemore. Cons. Engr. (Hall & Bacon), National Bank Bldg., New Britain, Conn. (*Jun., Dec. 5, 1905*)	May 3, 1910
Baeta-Neves, Lourenco. Chf. Engr., Technical Dept. of Railways, Public Works and Industries, Bello Horizonte, Minas Geraes, Brazil	Nov. 30, 1909
Bake, William Sibson. Asst. Engr., G. R. & I. Ry., Office of Chf. Engr., Grand Rapids, Mich	Jan. 4, 1910
Baker, Elisha Brown. Contr., Herkimer, N. Y	April 1, 1896

	Date of Membership
Baker, Harold James Manning. Junior Engr., U. S. Engr.'s Office, P. O. Box 1809, Seattle, Wash. *(Jun., Oct. 7, 1902)*	Mar. 4, 1908
Baker, Henry Erskine. Engr., Chinese Govt. Paper Mills, Hankow, China.	May 7, 1902
Baker, Hugh Cossart, Jr. Sales Mgr., The Manitoba Bridge & Iron Works, Ltd., Winnipeg, Man., Canada	May 4, 1904
Baker, Percival Stevens. Computer, P. & R. Ry., 520 Reading Terminal, Philadelphia, Pa. *(Jun., Sept. 4, 1906)*	Oct. 2, 1907
Baker, Sheldon King. Asst. Engr., U. S. Reclamation Service, Phœnix, Ariz. *(Jun., June 5, 1906)*	Mar. 4, 1908
Balch, Leland Rella. Asst. Engr., U. S. Reclamation Service, Powell, Wyo	Oct. 5, 1909
Baldwin, George Herbert. 2632 Channing Way, Berkeley, Cal	Jan. 8, 1908
Baldwin, Hiram Ellsworth. 10532 Earle Ave., Cleveland, Ohio	Jan. 2, 1895
Ball, Laurence Adams. Chf. Draftsman, Hay Foundry & Iron Works, Newark, N. J. *(Jun., May 3, 1904)*	Feb. 6, 1907
Ballou, Henry Welcome. 735 Banigan Bldg., Providence, R. I	Nov. 7, 1906
Balz, Louis Christian Frederick. U. S. Eng'rs. P. O. Drawer 7, The Dalles, Ore	Feb. 5, 1908
Bance, Charles William. Contr. Engr., 1 Montgomery St., Jersey City, N. J	Mar. 5, 1902
Bandy, James Marcus. Cons. Hydr. and San. Engr., Greensboro, N. C	Feb. 4, 1903
Banks, George Hill. U. S. Engr. Office, Houghton, Mich	Sept. 4, 1907
Banks, John Edwin. Engr., Bureau of Standards, Am. Bridge Co., Ambridge, Pa	June 4, 1902
Bannister, Carl Lincoln. Asst. Engr., Barge Canal Office, Rome, N. Y.	May 3, 1905
Bantel, Edward Christian Henry. Adjunct Prof. of Civ. Eng., Univ. of Texas, 2307 San Antonio St., Austin, Tex	Feb. 4, 1903
Barker, Charles Whitney Tillinghast. Pres., Field, Barker & Underwood, Inc., Engrs. and Contrs., 718 Arcade Bldg., Philadelphia, Pa. *(Jun., June 6, 1905)*	June 1, 1909
Barkmann, Ernst Henry. Care, Mo. Val. Bridge & Iron Co., Leavenworth, Kans	Oct. 7, 1908
Barlow, De Witt Dukes. Engr., Atlantic, Gulf & Pacific Co., 1132 Gresham Rd., Plainfield, N. J	Feb. 7, 1906
Barlow, James Evans. Engr. with Bureau of Municipal Research, 911 Neave Bldg., Cincinnati, Ohio. *(Jun., Sept. 4, 1906)*	Mar. 1, 1910
Barlow, John Sadler. 1222 E. Boulevard, El Paso, Tex	May 6, 1908
Barnard, Elmer Ellsworth. Asst. City Engr., Krise Bldg., Lynchburg, Va. *(Jun., Jan. 31, 1905)*	May 3, 1910
Barnard, Wilfred Keefer. Engr., M. of W. and Structures, Pacific Elec. Ry. Co., 6th and Main Sts., Los Angeles, Cal	Nov. 8, 1909
Barnes, Frank William, Jr. J. G. White & Co., Parksville, Tenn	Dec. 6, 1910
Barnes, Fred Asa. Asst. Prof., Ry. Eng., Cornell Univ., Ithaca, N. Y	Dec. 7, 1904
Barnes, Walter Esmond. 32 Lincoln St., Malden, Mass. *(Jun., May 6, 1902)*	Dec. 6, 1905
Barnes, William Thomas. With Metcalf & Eddy, 14 Beacon St., Boston (Res., 57 Grafton St., Newton Center), Mass	Sept. 7, 1898
Barnett, Robert Crary. Cons. Engr., 510 Kansas City Life Bldg., Kansas City, Mo	Dec. 5, 1900
Barney, Percy Canfield. Prin. Asst. Engr., Board of Water Supply, 165 Broadway, New York City. *(Jun., Mar. 3, 1896)*	June 5, 1901
Barratt, Sydney Alfred. Supt., Ponupo Manganese Co., Santiago de Cuba, Cuba	April 1, 1908
Barrett, Robert Edward. Asst. Engr.-Designer, New York Board of Water Supply, 165 Broadway, New York City. *(Jun., Jan. 31, 1905)*.	Dec. 6, 1910
Bartell, Max John. Asst. Engr., City Engr.'s Office, Hewes Bldg., San Francisco, Cal. *(Jun., May 1, 1906)*	Oct. 5, 1909
Bartoccini, Astolfo. 55 Duane St., New York City	May 6, 1903
Barton, Calvin Lewis. Vice-Pres., McHarg-Barton Co., Contrs., 165 Broadway, New York City	April 4, 1906
Barton, Walter Chew. 3338 St. Charles Ave., New Orleans, La	July 1, 1908
Bascome, Western Radford. Asst. to Chf. Engr., Dept. of Bridges, 140 Claremont Ave., New York City. *(Jun., Dec. 3, 1891)*	May 5, 1897
Bass, Frederic Herbert. Director, Eng. Div., Minnesota State Board of Health, Minneapolis, Minn	Nov. 6, 1907
Bassell, Guy Mannering. 741 Mulberry St., Clarksburg, W. Va	Feb. 6, 1907
Bassett, Robert Jay. 84 Lawrence St., Yonkers, N. Y. *(Jun., Feb. 3, 1903)*	Feb. 3, 1904
Batchelder, Benjamin Franklin. Potsdam, N. Y	Jan. 4, 1910
Bates, John Schuyler. City Engr., 231 South 4th St., Monmouth, Ill	Mar. 1, 1910
Bates, William Bernard. Cons. Engr. (Huggins & Bates), 6th Floor, Strickland Bldg., Roanoke, Va	Nov. 6, 1907
Baum, Frank George. Cons. Elec. and Hydr. Engr., Chronicle Bldg., San Francisco, Cal	July 9, 1906
Bausher, Carmi Irving. Asst. Engr., B. and C. Dept., The Penna. Steel Co., Steelton; Address, 136 North 13th St., Harrisburg, Pa	Dec. 7, 1898

	Date of Membership
Baxter, David Elder. 32 West 60th St., New York City. (*Jun., May 2, 1899*)	July 9, 1906
Bayley, Charles Abercrombie Dunbar. 99 Heywood Ave., Orange, N. J.	Dec. 1, 1908
Baylis, Arthur Raymond. New England Eng. Co., Eng. Dept., 50 Church St., New York City	June 6, 1906
Beach, James George. Archt. (Doyle, Patterson & Beach), Worcester Bldg., Portland, Ore. (*Jun., Aug. 31, 1897*)	Sept. 2, 1903
Beach, William Nicholas. 29 Broadway, New York City	July 1, 1909
Beal, George Safford. Res. Engr., Lake Altoona, 1810 Thirteenth St., Altoona, Pa.	June 6, 1906
Beale, Carroll. (Beale & Meigs), Washington Loan & Trust Bldg., Washington, D. C.	Oct. 5, 1909
Beale, Harry Orlando. Care, U. S. Reclamation Service, Fort Shaw, Mont.	Oct. 5, 1909
Bebb, Edward Crosby. Engr., U. S. Reclamation Service, 26 T St., N. W., Washington, D. C.	Nov. 6, 1907
Bebout, Guy Burnet. Junior Engr., U. S. Engr. Office, Wheeling, W. Va.	June 30, 1910
Becker, Elvin Jay. Asst. Engr. in Chg. of Constr., Contr. No. 11, Barge Canal, Waterford, N. Y. (*Jun., April 3, 1906*)	Mar. 1, 1910
Becker, Sylvanus A. Instr. in Civ. Eng., Lehigh Univ., 103 North St., Bethlehem, Pa. (*Jun., Dec. 1, 1903*)	Feb. 5, 1908
Beekman, John Vandeveer, Jr. Gen. Mgr., Whidden & Co., Inc., 155 Milk St., Boston, Mass. (*Jun., Sept. 3, 1901*)	July 10, 1907
Beer, Paul. Mgr., The Barber Asphalt Pav. Co., Des Moines, Iowa	Oct. 4, 1905
Beeson, Alexander Conn. 14 Lincoln Ave., Crafton, Pa.	May 1, 1907
Begien, Ralph Norman. Asst. to Gen. Mgr., B. & O. R. R., B. & O. Bldg., Baltimore, Md.	June 7, 1905
Belcher, Wallace Edward. Structural Engr., H. M. Byllesby & Co., Inc., 218 La Salle St., Chicago, Ill. (*Jun., Dec. 2, 1902*)	June 3, 1908
Belknap, Francis Wheelwright. Engr. and Gen. Mgr., Phœnix Const. Co., 41 Park Row, New York City	Feb. 1, 1905
Bell, Alfred Carroll. Contr. Engr., Wisconsin Bridge & Iron Co., 605 Colby-Abbot Bldg., Milwaukee, Wis. (*Jun., May 2, 1893*)	Jan. 2, 1901
Bellows, Daniel Everett. Asst. Engr., N. Y. State Barge Canal, Box 68, Clyde, N. Y. (*Jun., April 30, 1907*)	July 1, 1908
Benedict, Harold Willoughby. Asst. Engr., N. Y. State Barge Canal, 705 Third Ave., North, Troy, N. Y.	Jan. 3, 1911
Benham, Webster Lance. Engr. and Contr., 714 Campbell Bldg., Oklahoma City, Okla.	April 5, 1910
Bennett, Charles Noble. Astoria, Ore.	Dec. 4, 1907
Benson, Newton Davis. Engr. and Contr., 8 Dawson St., Providence, R. I.	July 10, 1907
Bentley, John Clark. Asst. Engr., N. Y., O. & W. Ry., Middletown, N. Y.	May 31, 1910
Bergendahl, Gustave Storm. Civ. and Contr. Engr., 1432 Syndicate Trust Bldg., St. Louis, Mo.	April 3, 1907
Berger, Bernt. Cons. Engr., 45 Broadway, New York City	April 5, 1893
Berger, John. 335 Madison Ave., Room 1106, New York City	Oct. 2, 1907
Berry, Claude. Thomson, Carroll Co., Ill.	Feb. 6, 1907
Berry, Francis Rigdon. Care, St. Joseph Water Co., St. Joseph, Mo. (*Jun., Dec. 2, 1902*)	Nov. 8, 1909
Berry, Leslie Graham. Washington, N. C.	Dec. 1, 1908
Best, John Henry. Pres. and Gen Mgr., Best Constr. Co., Wapato, Wash.	June 1, 1904
Betts, Edward Everett. Engr., Chickamauga and Chattanooga National Military Park, Chattanooga, Tenn.	April 5, 1899
Beugler, Charles Ernest. 6509 Wheeler St., Oakland, Cal.	Oct. 2, 1907
Bevan, Lynne John. Asst. Engr., Vielé, Blackwell & Buck, 49 Wall St., Room 601, New York City	May 3, 1910
Bieler, Alphonsos Henry. Engr. of Bldg. Constr. with Horace Trumbauer, Archt., 200 Fifth Ave., New York City	June 7, 1905
Bilger, Harry Edmund. Care, State Highway Comm., Springfield, Ill.	Aug. 31, 1909
Billingsley, James Wartelle. Chronicle Bldg., Houston, Tex.	May 6, 1908
Binford, Charles Munnerlyn. Engr., Piney Min. Co., Stanaford (Res., Riley), Raleigh Co., W. Va.	Dec. 6, 1910
Bingham, Clarence Arminger. City Engr., Carlisle, Pa. (*Jun., June 5, 1906*)	Jan. 4, 1910
Bischoff, Julius Montgomery. Asst. Engr., Terminal R. R. Assoc., Room 210, Union Station (Res., 2736 Ann Ave.), St. Louis, Mo.	Jan. 4, 1910
Bissell, Clinton Talcott. Structural and Elec. Engr., National Board of Fire Underwriters, 135 William St., New York City	Dec. 5, 1906
Bixby, William Flint. City Engr., Sierra Madre; (Bixby & White, Civ. and Hydr. Engrs.), 502 Mason Bldg., Los Angeles, Cal. (*Jun., Feb. 5, 1907*)	April 5, 1910
Blaauw, Geert. Designing Engr., Long Sault Development Co. and St. Lawrence River Power Co., Massena, N. Y.	Nov. 30, 1909
Black, Edward Fryling. Instr. in Eng., Anglo-Chinese Coll., Foochow, China. (*Jun., Oct. 31, 1905*)	Nov. 4, 1908
Black, Ernest Bateman. Vice-Pres., The J. S. Worley Co., 207 Reliance Bldg., Kansas City, Mo.	Nov. 1, 1910

	Date of Membership
Black, Gurdon Gilmore. Engr. in Chg., Supply and Purifying Div., St. Louis Water Dept., 34 East Grand Ave., St. Louis, Mo	Oct. 5, 1909
Black, Ralph Peters. Engr., M. of W., Kanawha & Mich. Ry., Charleston, W. Va	Nov. 8, 1909
Blackmore, George Glover. Constr. Engr. and Supt., 150 Lexington Ave., New York City	Nov. 30, 1909
Blackwell, Paul Alexander. Asst. Chf. Engr., Virginia Bridge & Iron Co., Roanoke, Va. (*Jun., Dec. 4, 1900*)	Jan. 3, 1906
Blair, McCrea Parker. City Engr., City Hall, St. Boniface, Man., Canada	Feb. 2, 1909
Blamphin, Arthur Merrick Newberry. Asst. City Engr., Room 19, City Hall, New Orleans, La. (*Jun., Dec. 3, 1907*)	Feb. 2, 1909
Blanchard, Arthur Clarence Douglas. Asst. to City Engr., Toronto, Ont., Canada	April 5, 1910
Bland, Miles Carlisle. Chf. Engr., The Massillon Bridge & Structural Co., P. O. Box 196, Massillon, Ohio	Sept. 3, 1902
Blatt, Max. Asst. Engr., Dept. of Water Supply, Gas and Electricity (Res., 811 Cauldwell Ave.), New York City	Oct. 5, 1909
Blaylock, John Charles. Structural Engr., 5439 Southport Ave., Chicago, Ill	Mar. 2, 1909
Bliem, Daniel William. Asst. to Operating Mgr., Am. Bridge Co., Pennsylvania Bldg., Philadelphia, Pa	June 5, 1907
Bliss, Edwin Packard. Cons. and Con. Engr. (H. P. Converse & Co.), 88 Broad St., Boston, Mass	July 9, 1906
Bliss, George Henry. Div. Engr., U. S. Reclamation Service, Boise, Idaho	Sept. 7, 1904
Blood, Charles Frederick. Ridgefield, N. J	Oct. 5, 1909
Blythe, Lucien Hoguet. 201 Bay 31st St., Brooklyn, N. Y. (*Jun., Oct. 31, 1905*)	April 1, 1908
Boardman, Harold Sherburne. Dean of Coll. of Technology; Prof. of Civ. Eng., Univ. of Maine, Orono, Me	Feb. 3, 1904
Boardman, Howard Edward. Senior Asst. Engr., M. of W. Dept., Mo. Pac. Ry., St. Louis, Mo. (*Jun., Oct. 7, 1902*)	Jan. 4, 1905
Boatrite, James Edwin. Gen. Mgr., The Guerber Eng. Co., Bethlehem, Pa. (*Jun., Feb. 5, 1895*)	Nov. 3, 1897
Bogen, Louis Edward. Chf. Elec. Estimating Engr., The Allis-Chalmers Co. (Res., 171 Twenty-first St.), Milwaukee, Wis. (*Jun., April 30, 1895*)	June 4, 1902
Boller, Alfred Pancoast, Jr. 45 East 17th St., New York City. (*Jun., Oct. 2, 1894*)	May 3, 1899
Boltz, Thomas Franklin. Asst. Engr. and Supt. of Constr., Pacific & Eastern R. R., Eagle Point, Ore	Oct. 5, 1909
Bond, George Washington, Jr. Township Engr., Weehawken, N. J	Nov. 1, 1905
Bond, Judson Baker. Care, Conrad Land & Water Co., Fort Shaw, Mont	June 3, 1908
Boniface, Arthur. Asst. Engr., Rapid Transit Subway Constr. Co., 165 Broadway, New York City. (*Jun., Jan. 2, 1906*)	Oct. 4, 1910
Bonnett, Charles Pierre. Asst. Engr., Topographical Bureau, Borough of the Bronx (Res., 241 West 101st St.), New York City. (*Jun., June 2, 1886*)	Mar. 6, 1901
Booz, Horace Corey. Prin. Asst. Engr. of Branch Lines, P. R. R., 257 Broad St. Station, Philadelphia, Pa	April 4, 1906
Bos, George Albert. Cons. Engr., Associated with Lewis P. Hobart, Archt., Crocker Bldg., San Francisco, Cal	June 3, 1908
Boucher, William James. Div. Engr., Chicago Passenger Subways, 181 LaSalle St., Chicago, Ill	Sept. 6, 1905
Boude, Philip Bethel. Asst. to Div. Engr., Philadelphia Terminal Div., P. R. R., Thirty-second and Powelton Ave., Philadelphia, Pa	Mar. 1, 1910
Boughton, Will Hazen. Head of Civ. Eng. Dept., West Virginia Univ.; Cons. Engr. to the Board of Education, Morgantown Dist., Morgantown, W. Va	Nov. 6, 1907
Bourguignon, Joseph. 236 State St., Flushing, N. Y	May 31, 1910
Bourne, Thomas Johnstone. Dist. Engr., Tientsin-Pukow Ry. (Southern Section), Nanking, China	Feb. 7, 1900
Bowditch, John Henry. Asst. Div. Engr., N. Y. Div., B. & O. R. R., New Brighton, N. Y	July 10, 1907
Bowen, Edmund Ignatius. Supt., Delaware and Jefferson Divs., Erie R. R. Susquehanna, Pa	Nov. 1, 1899
Bowen, Sherman Worcester. Structural Engr., 5945 Cote Brilliante Ave., St. Louis, Mo	Sept. 7, 1904
Bowie, Clifford Pinkney. Asst. Engr., Associated Pipe Line Co., 1360 Spring St., Berkeley, Cal	Aug. 31, 1909
Bowler, Frank Colburn. Millinocket, Me	Oct. 5, 1904
Bowne, William Hunt. Glen Cove, N. Y	Dec. 7, 1904
Boyd, Butler Bennett. 3210 F St., San Diego, Cal	Nov. 8, 1909
Boyd, Robert Wright. Cons. Engr., 105 West 40th St., New York City	Jan. 8, 1908
Boyer, Charles Carroll. Address unknown	April 4, 1906
Bradshaw, Charles. Care, Bureau of Public Works, Manila, Philippine Islands	Nov. 6, 1907

ASSOCIATE MEMBERS B

	Date of Membership
Bradshaw, Sam Wigfall. Asst. Engr., Estimating Dept., Bridge and Constr. Dept., Pennsylvania Steel Co., Steelton, Pa. (*Jun., Oct. 2, 1900*).	Feb. 4, 1903
Brady, Joseph. 94 Seventh Ave., Brooklyn, N. Y. (*Jun., Sept. 5, 1905*) . .	Nov. 4, 1908
Branch, Lester Van Noy. Div. Engr., Porto Rico Irrig. Service, Juana Diaz, Porto Rico	June 3, 1908
Branch, Thomas Pettus. Prof., Civ. Eng., Georgia School of Technology, Atlanta, Ga	Feb. 5, 1902
Branne, John Severin. Cons. Engr., 1 Madison Ave., New York City (Res., 145 Chester St., Mt. Vernon, N. Y.)	Oct. 5, 1898
Bratton, Edward Elisha. Vice-Pres. and Engr., The Bratton Co., Engrs. and Contrs., Philadelphia, Pa	Oct. 2, 1907
Braune, Gustave Maurice. Asst. Chf. Bridge Designer, Care, Barge Canal, Albany, N. Y. (*Jun., June 2, 1896*)	Sept. 4, 1901
Braunworth, Percy Lewis. Prin. Asst. Engr. for John M. Farley, Cons. Engr., White Plains, N. Y	Jan. 3, 1911
Breed, Charles Blaney. Asst. Prof. in Civ. Eng., Mass. Inst. Tech.; (Barrows & Breed, Cons. Engrs.), 6 Beacon St., Boston, Mass	May 6, 1903
Breed, Henry Eltinge. 330 Manning Boulevard, Albany, N. Y	Mar. 4, 1908
Breneman, Paul Bruce. Prof. of Mechanics and Materials of Constr., in Chg. of the Laboratory for Testing Materials, The Pennsylvania State Coll., State College, Pa	Mar. 2, 1909
Brenn, Charles Ferdinand. Chf. Engr. of Mines, C., M. & St. P. Ry., 194 Fullerton Ave., Chicago, Ill	May 4, 1904
Brereton, Thomas John. Pres., Valley Spirit Pub. Co., Chambersburg, Pa. (*Jun., Oct. 7, 1885*)	June 5, 1895
Brewer, Jesse Irving. Asst. Engr., Interborough Rap. Tran. Co., 32 Park Pl., New York City	Oct. 5, 1909
Briggs, Harry Alson. Engr. with MacArthur Bros. Co., Brown Station, N. Y	May 1, 1907
Bright, Charles Edwin. U. S. Supt., Colbert Shoals Canal, Riverton, Ala.	Dec. 3, 1902
Brillhart, Jacob Herbst. Chf. Engr., The Guerber Eng. Co. (Res., 342 North Seventh Ave.), Bethlehem, Pa. (*Jun., Nov. 1, 1904*)	Nov. 4, 1908
Brink, Lawrence Calvin. Gen. Supt., Pittsburg Contr. Co., in Chg. of Contract No. 52, Catskill Aqueduct, Elmsford, N. Y	Oct. 7, 1908
Brinkley, Milo Hamilton. Asst. Engr., G. N. Ry., 310 King St. Station, Seattle, Wash. (*Jun., Mar. 1, 1904*)	Jan. 8, 1908
Brinsmade, Daniel Edwards. Secy., The Ousatonic Water Power Co., Box 95, Derby, Conn	April 6, 1904
Brodie, Orrin Lawrence. Asst. Designing Engr., Board of Water Supply, 165 Broadway, New York City	July 10, 1907
Brogan, Thomas Byrnes. Insp., Board of Water Supply of New York City, 596 Riverside Drive, New York City	Feb. 1, 1910
Brook-Fox, Evelyn. Care, National Bank of India, Calcutta, India	Feb. 2, 1898
Brooke, George Doswell. Div. Engr., B. & O. R. R., Camden Station, Baltimore, Md	Nov. 7, 1906
Brooks, John Pascal. Associate Prof. of Civ. Eng., Univ. of Illinois, 1005 California Ave., Urbana, Ill	April 1, 1896
Brooks, Miles Elijah. Locating Engr., Kettle River Val. Ry., Penticton, B. C., Canada	July 9, 1906
Brower, Edward Sylvester. Cons. Engr., 95 Liberty St., New York City.	Dec. 2, 1903
Brower, Irving Clinton. Asst. Engr., Chic. & Northwestern Ry., Care, E. C. Carter, Chf. Engr., Chicago, Ill	Nov. 30, 1909
Brown, Alfred Thomas. Asst. Engr., Board of Water Supply, White Plains, N. Y. (*Jun., Nov. 1, 1904*)	Jan. 5, 1909
Brown, Burtis Scott. Structural Engr., 161 Devonshire St., Room 709, Boston, Mass	Oct. 5, 1909
Brown, Charles Eugene. 33 Oakwood Ave., Hudson Heights, N. J	Mar. 4, 1908
Brown, Charles Franklin. 317 Boston Bldg., Salt Lake City, Utah	Oct. 7, 1908
Brown, Clark. Barge Canal Office, Albany, N. Y	April 1, 1908
Brown, Collingwood Bruce, Jr. Div. Engr., C. P. Ry., Montreal, Que., Canada. (*Jun., Oct. 1, 1901*)	April 6, 1909
Brown, Harry William. Care, P., C., C. & St. L. Ry., Logansport, Ind.	April 5, 1910
Brown, Marshall Wright. 137 S. Broadway, Nyack, N. Y	Nov. 4, 1908
Brown, Robert Huse. Engr., Pacific Flush Tank Co., 920 Singer Bldg. (Res., 21 West 127th St.), New York City. (*Jun., June 6, 1905*)	April 5, 1910
Brown, Robert King. Engr., M. of W., S. P., L. A. & St. L. R. R. Co., Room 228, Union Station, Salt Lake City, Utah	June 7, 1893
Brown, Rodman Merritt. Pres., Brown & Read Co., Engrs. and Contrs., 1212 Hartford Bldg., Chicago, Ill	Feb. 1, 1905
Brown, Samuel Coughlin. 15 West 83d St., New York City	Nov. 1, 1905
Brown, Seymour Dewey. Brazil Ry. Co., 9 Rue Louis le Grand, Paris, France	Oct. 4, 1910
Brownell, Leonard Dempster. Asst. Engr., Dept., State Engr. and Surv., 112 South Chester St., Syracuse, N. Y	Nov. 6, 1907
Bruce, John Augustus. Sewer Engr., City of Omaha; Civ. and Municipal Engr. (The Consolidated Eng. Co.), 644 Bee Bldg., Omaha, Nebr	Sept. 6, 1910

	Date of Membership
Bruning, Henry Diedrich. Cons. Engr., 404 White Bldg., Seattle, Wash.	Oct. 7, 1908
Brunnier, Henry John. Cons. Structural Engr., 671 Monadnock Bldg., San Francisco, Cal.	Jan. 3, 1911
Bruntlett, Eugene Harry. Engr., Security Bridge Co. (Res., 2453 Garfield Ave., South), Minneapolis, Minn. (*Jun., June 6, 1905*)	June 30, 1910
Brush, Carl Fletcher. Eyota, Minn.	Mar. 4, 1908
Brush, William Whitlock. Deputy Chf. Engr., Dept. of Water Supply, Gas and Electricity, 13 Park Row, New York City. (*Jun., Mar. 3, 1896*).	April 5, 1905
Bryson, Thomas Bines. Contr. Engr., 165 Broadway, New York City	Feb. 7, 1900
Buck, Con Morrison. Cons. Engr., 615 Poyntz Ave., Manhattan, Kans.	Dec. 6, 1905
Bugbee, Newton Albert Kendall. 207 Academy St., Trenton, N. J.	Oct. 5, 1904
Bullen, Roy. Logan, Utah. (*Jun., May 1, 1906*)	Mar. 1, 1910
Bumsted, Eugene Bradford. Hydr. Engr., Stone & Webster Eng. Corporation, Reno, Nev. (*Jun., May 1, 1900*)	Mar. 6, 1907
Bunker, Stephen Sans. Asst. Engr., Madeira-Mamoré Ry., Box 304, Manãos, Brazil	Oct. 4, 1910
Bunnel, William Cyrus. U. S. Asst. Engr., U. S. Engr. Office, Box 155, Manila, Philippine Islands. (*Jun., Oct. 1, 1901*)	Jan. 2, 1907
Burchard, Anson Wood. 21 Front St., Schenectady, N. Y.	May 3, 1893
Burden, Morton. Care, Eng. Dept., Am. Bridge Co., Frick Bldg., Pittsburg, Pa. (*Jun., Feb. 4, 1896*)	Jan. 2, 1901
Burdick, Charles Baker. Hydr. and San. Engr., 1212 Hartford Bldg., Chicago, Ill.	Mar. 1, 1905
Burgess, Philip. Hydr. and Chemical Engr. (Burgess & Long), 828 Cols. Savings and Trust Bldg., Columbus, Ohio	Nov. 7, 1906
Burgoyne, John Henry, Jr. Engr., Chimbote Ry., Chimbote, Peru. (*Jun., Sept. 1, 1903*)	Dec. 5, 1906
Burke, Ralph Haney. Computer, San. Dist. of Chicago, 1546 South Kedzie Ave., Chicago, Ill. (*Jun., Dec. 4, 1906*)	Oct. 4, 1910
Burns, Joseph Patrick. 339 Franklin St., Watertown, N. Y.	Dec. 1, 1908
Burns, Louis Andrew. Asst. Engr., N. Y. State Barge Canal Office, Phœnix, N. Y.	July 1, 1909
Burns, Walter Elliott. 911 O St., Sacramento, Cal. (*Jun., Mar. 5, 1907*).	Dec. 6, 1910
Burrage, John Otis. Cons. Engr., 3400 Washington St., San Francisco, Cal. (*Jun., Mar. 1, 1904*)	Nov. 4, 1908
Burrell, Glenn Smith. Asst. Civ. Engr., U. S. N., Naval Station, Honolulu, Hawaii	Aug. 31, 1909
Burroughs, Frederic. Care, City Engr., City Bldg., Altoona, Pa. (*Jun., June 4, 1907*)	May 3, 1910
Burroughs, Hector Robins. 570 Jefferson Ave., Brooklyn, N. Y. (*Jun., Mar. 3, 1908*)	Sept. 6, 1910
Burt, Luther Harold. Asst. Engr., Bronx Valley Sewer Comm., 2 Grand St. (Res., 3 Borneman Pl.), White Plains, N. Y.	Nov. 1, 1910
Burton, William. With B. Douglas, Cons. and Contr. Engr., 814 Ford Bldg. (Res., 108 Charlotte Ave.), Detroit, Mich. (*Jun., Oct. 3, 1905*).	May 4, 1909
Burwell, Robert Lemmon. Asst. Engr., Baltimore Sewerage Comm., Storm Water Div., 1405 Park Ave., Baltimore, Md. (*Jun., Dec. 3, 1901*)	July 1, 1908
Bush, Adam Leonard. Chf. Engr. for Parkinson & Bergstrom, 1035 Security Bldg., Los Angeles, Cal.	Oct. 4, 1910
Bush, Philip Lee. Supt., Supply and Constr. Dept., Cal. Fruit Canners Assoc., 120 Market St., San Francisco, Cal.	Sept. 5, 1906
Busse, Franz August. 800 Third St., Louisville, Ky.	April 5, 1910
Butchers, Earle Burdette. Draftsman for Am. Bridge Co., Ambridge, Pa.	Jan. 8, 1908
Butler, Alfred Dickey. Chf. Asst. City Engr., Spokane, Wash.	Oct. 5, 1909
Butler, George. County Surv., Court House, San Diego, Cal.	Sept. 6, 1910
Butler, John Soule. U. S. Junior Engr., Lock No. 21, Eadsville, Ky.	Mar. 4, 1908
Butler, Millard Angle. 1026 Paulsen Bldg., Spokane, Wash.	Jan. 3, 1911
Butterfield, Herbert Mitchell. Care, Riley, Hargreaves & Co., 5 Battery Rd., Singapore, Straits Settlements	Oct. 3, 1906
Butz, George Wishart. Schuylkill Haven, Pa.	April 6, 1909
Buzzell, Josiah William. 507 Park Ave., East Orange, N. J.	April 6, 1904

Cadle, Charles Longford. Elec. Engr., New York State Rys., Rochester, N. Y.	Nov. 1, 1910
Caldwell, Fred Edward. Newton, N. J. (*Jun., April 3, 1906*)	Feb. 1, 1910
Calhoun, David Adams. Cons. Engr., 35 Nassau St., New York City. (*Jun., Oct. 6, 1908*)	May 31, 1910
Cameron, Harry Frank. Div. and Chf. Engr., Osmeña Water-Works System, Cebu, Philippine Islands	Oct. 2, 1907
Cameron, John Bobbs. Asst. Engr., Constr. Dept., B. & O. R. R., Somerset, Pa. (*Jun., Oct. 2, 1900*)	Feb. 3, 1904
Campbell, Duncan Hugh. 610 West Hollywood Boulevard, Hollywood Station, Los Angeles, Cal.	July 1, 1909

	Date of Membership
Campbell, Henry Avery. Engr. in Chg. of Bureau of Inspection of the Merchants Assoc., 1039 Merchants Exchange Bldg., San Francisco, Cal. (*Jun., April 4, 1905*)	April 6, 1909
Carberry, Ray Sheppard. Supt., Imperial Water Co. No. 1, Imperial, Cal.	Mar. 4, 1908
Carey, Edward Gilman. Asst. Engr. with E. DeV. Tompkins, 81 East 125th St., New York City	July 1, 1909
Carhart, Frank Milton. Asst. State Engr., Eng. Dept., State of Idaho, Boise, Idaho	Nov. 8, 1909
Carpenter, Clarence Edson. Road Engr., Interborough Rap. Tran. Co., New York City, 33 Bruce Ave., Yonkers, N. Y	July 10, 1907
Carr, Dean Orrice. Asst. to Designing Engr., Central Water-Works, Tenn. Coal, Iron & R. R. Co., Birmingham, Ala	Oct. 4, 1910
Carrick, Robert Edward. Engr., The Gen. Fireproofing Co., 257 East 133d St., New York City. (*Jun., April 30, 1907*)	April 6, 1909
Carroll, Charles Joseph. Supt., Cia Constructadera de Ferrocarriles, Calle Coleaso No. 139, Durango, Mexico	Oct. 5, 1904
Carstarphen, Frederick Charles. Min. Engr., 514 Ideal Bldg., Denver, Colo	April 6, 1909
Carter, Alfred Ellsworth. Res. Engr., Rapid Transit Subway Constr. Co. (Res., 706 West 180th St.), New York City	June 4, 1902
Carter, Frank Harvie. 147 Magazine St., Cambridge, Mass	Jan. 4, 1905
Carter, Richard William. Bridge Engr., Key West Extension, Florida East Coast Ry., Marathon, Fla	Oct. 1, 1902
Carver, George Payson. 53 State St., Boston, Mass	Oct. 2, 1907
Case, George Wilkenson. Asst. Prof. in Eng., Purdue Univ., 113 South Grant St., West Lafayette, Ind	Sept. 6, 1910
Cauthorn, Edward Beauford. City Engr., Columbia, Mo	June 5, 1907
Chace, Ira Mason, Jr. Mgr., New Bedford Office, J. W. Bishop Co., Gen. Contrs., New Bedford, Mass	Oct. 2, 1907
Chadbourne, Edward Merriam. Pres. and Gen. Mgr., E. M. Chadbourne Co., Engrs. and Contrs., 800 Postal Telegraph Bldg., San Francisco, Cal. (*Jun., Nov. 3, 1903*)	Oct. 2, 1907
Chamberlaine, Robert Lloyd. Engr. of Way, United Rys. & Elec. Co., 1008 Continental Bldg., Baltimore, Md	Oct. 2, 1907
Chambers, Henry Wick. Asst. Engr., Office of Vice-Pres. and Gen. Mgr., N. Y. C. & H. R. R. R., 1012 Grand Central Terminal, New York City.	Feb. 5, 1908
Chandler, Elwyn Francis. Prof. of Math., in Chg. of Civ. Eng., Univ. of North Dakota, University, N. Dak	Feb. 1, 1910
Chapman, Harry Day. City Engr. and Supt. of Streets, Richmond, Cal	Oct. 7, 1908
Chapman, Paul. 1546 Minford Pl., Bronx, New York City	June 6, 1906
Chappell, Claude Edward. Res. Engr., Wayne St. Drawbridge, St. Joseph (Res., 402 S. Main St., Charlotte), Mich. (*Jun., Sept. 1, 1908*)	Sept. 6, 1910
Charles, La Vern John. Asst. Engr., U. S. Reclamation Service, 714 East 3d St., Ellensburg, Wash	Oct. 7, 1908
Charlsworth, William Saxon. County Engr., Le Karaka, Poverty Bay, New Zealand	Nov. 1, 1899
Charnley, Walter. Engr. in Chg. of Constr., Mexico North Western Ry., Pearson, Chih., Mexico	May 4, 1909
Chase, Frank David. Archt., Western Elec. Co., 1655 East 55th St., Chicago, Ill	June 30, 1910
Chase, Richard Davenport. 59 Fourth St., New Bedford, Mass. (*Jun., Oct. 5, 1897*)	Oct. 3, 1900
Chase, Russell. Prin. Asst. Engr., O. R. & N. Co., New Wells-Fargo Bldg., Portland, Ore	Feb. 1, 1905
Chase, William Henry. 162 Allen St., New Bedford, Mass	April 3, 1907
Chassaing, Charles Willis. Care, Selden-Breck Constr. Co., Fullerton Bldg., St. Louis, Mo	Sept. 6, 1910
Chester, Charlie Ellsworth. Civ. Engr. and Mgr. of Water Co., Shelbyville, Ill	May 4, 1898
Chew, Richard Sanders. 607 Humboldt Bank Bldg., San Francisco, Cal	Sept. 5, 1906
Chiba, Toshitomo. Care, Mr. Narisawa, 5 Kitajimacho 2 Chome, Nihonbashiku, Tokyo, Japan. (*Jun., Mar. 31, 1908*)	Sept. 6, 1910
Chipman, Paul. Room 4, Dickman Bldg., Evansville, Ind	Oct. 2, 1907
Churchill, Percival Mitchell. Cons. Engr., Boston, Mass	June 1, 1904
Cilley, Morgan. Dist. Engr., Dist. XII, Bureau of Public Works, Cagayan, Misamis, Philippine Islands	Nov. 8, 1909
Clapp, Frank Lemuel. Asst. Engr., Board of Water Supply of City of New York, Cornwall-on-Hudson, N. Y	May 4, 1909
Clapp, George Hubbard. Pres., Pittsburgh Testing Laboratory, 325 Water St., Pittsburg, Pa	July 1, 1891
Clapp, Sidney Kingman. Asst. Engr., Board of Water Supply, West Shokan, N. Y	April 5, 1905
Clapp, Wilfred Atherton. Civ. Engr. and Supt. of Constr., Quartermaster's Dept., U. S. A., 103 Sherman St., Portland, Me	April 4, 1906
Clark, Arthur Edward. Asst. Engr., Public Service Comm. for First Dist., 23 Flatbush Ave., Brooklyn, N. Y	Oct. 4, 1910

	Date of Membership
Clark, Edwin. Structural Engr. and Chf. of the Bureau of Bldg. Inspection, Room 313, City Hall, Philadelphia, Pa	Jan. 6, 1897
Clark, Warren Vester. 500 First National Bank Bldg., Berkeley, Cal	Mar. 7, 1906
Clarke, Elwyn Lorenzo. Civ. and Hydr. Engr., 126 North Main St., Sheridan, Wyo	April 1, 1908
Clarke, William Dexter. (Hegardt & Clarke), Board of Trade Bldg., Portland, Ore	July 10, 1907
Class, Charles Frank. Asst. Engr., Am. Coke & Gas Constr. Co. (Res., 1468 Kenwood Ave.), Camden, N. J. (*Jun., Mar. 3, 1903*)	April 4, 1906
Clausen, Jacob Centennial. Engr. in Chg. of Sewer Constr. and Maintenance, 2063 West 28th St., Los Angeles, Cal	Sept. 6, 1905
Claybaugh, Harry Wray. Div. Engr., Pa. State Highway Dept., Franklin, Pa	June 1, 1909
Cleaver, Pitson Jay. Montezuma, N. Y. (*Jun., April 4, 1899*)	May 1, 1907
Cleveland, Henry Burdett. Prin. Asst. Engr., New York State Dept. of Health, Albany, N. Y	May 31, 1910
Clinton, Samuel Dexter. Chf. Engr., Portneuf-Marsh Val. Irrig. Co., Downey, Idaho	Oct. 5, 1909
Coates, Frank Raymond. Vice-Pres., Inter-Ocean Steel Co., 217 Railway Exchange, Chicago, Ill	Jan. 3, 1900
Cobb, Stephen Prentis. Supt., Gas Dept., Albany Southern R. R. Co., Albany, N. Y	Mar. 4, 1908
Coe, Robert. With Carnegie Steel Co., 1317 Spruce St., Philadelphia, Pa	Sept 6, 1910
Cohen, Charles. Engr. for Am. Real Estate Co., 989 Southern Boulevard, Bronx, New York City	Mar. 6, 1907
Cokefair, Francis Albertson. Chf. Engr., Great Northern Power Co., Duluth, Minn	April 6, 1904
Cole, Burt. Engr., Mt. Olive & Staunton Coal Co., Staunton, Ill	Jan. 2, 1901
Cole, Clinton Llewellyn. With The H. Wales Lines Co. (Res., 94 Linsley Ave.), Meriden, Conn	May 6, 1908
Cole, Edward Smith. Hydr. Engr., 220 Broadway, New York City	Sept. 7, 1904
Cole, Herbert Nichols. Constr. Engr., Semet Solvay Co., Syracuse, N. Y	Jan. 6, 1904
Cole, Osman Fred. Vice-Pres. of the Dunlap Eng. Operating Co., 535 Marquette Bldg., Chicago, Ill	Sept. 2, 1908
Coleman, Henry Fitch. 404 Seventh St., Logansport, Ind	Mar. 6, 1895
Collar, William Franklin. Supt., The Foundation Co., Negaunee, Mich. (*Jun., April 6, 1909*)	Jan. 3, 1911
Collins, Charles Edwin. Cons. Engr., 321 Drexel Bldg., Philadelphia, Pa	Mar. 2, 1904
Collins, Clarke Peleg. Civ. and Min. Engr., 809 Johnstown Trust Bldg., Johnstown, Pa	June 4, 1902
Collins, Francis Winfield. Hartsdale, N. Y. (*Jun., Jan. 2, 1906*)	Sept. 6, 1910
Collins, Frank David. Engr., Koken Iron Works, St. Louis, Mo	Oct. 7, 1908
Collins, Frank Joseph. Supt., James Stewart & Co., 412 Franklin St., Buffalo, N. Y	Nov. 8, 1909
Collins, George James Schilling. 414 Bee Bldg., Omaha, Nebr	June 5, 1907
Collins, John T. Res. Engr., N. Y. C. & H. R. R. R. Co., Grand Central Palace, New York City	May 1, 1907
Collins, Stewart Garfield. 705 Sellwood Bldg., Duluth, Minn	Nov. 1, 1910
Colnon, Redmond Stephen. Gen. Contr. (Fruin & Colnon), 615 Laclede Bldg., St. Louis, Mo	July 9, 1906
Coltman, Robert, Jr. 112 The Wellington, Washington, D. C	Oct. 4, 1910
Colvin, Donald Dean. Asst. Chf. Engr., Vera Cruz al Istmo and Pan-American Rys., Tierra Blanca, Vera Cruz, Mexico	May 6, 1908
Comstock, Harold Dearborn. Asst. Engr., U. S. Reclamation Service, Pathfinder, Wyo	April 5, 1910
Congdon, John Potter. Superv. Engr., Oregon Short Line R. R., Pocatello, Idaho	May 3, 1905
Conger, Alger Adams. Asst. Hydr. Engr., J. G. White & Co., 43 Exchange Pl., New York City	Oct. 1, 1902
Conkling, Leon De Vere. Associate Prof. of Civ. Eng., Lehigh Univ., South Bethlehem, Pa	Dec. 4, 1901
Conley, Clyde Greyson. Asst. Engr., The Mt. Vernon Bridge Co., Mt. Vernon, Ohio	Aug. 31, 1909
Connell, Henry Leo. Asst. Engr., Board of Water Supply of New York City, Pleasantville, N. Y	Jan. 4, 1910
Conner, Ralph Melvin. 17 Hutchinson St., Winthrop, Mass. (*Jun., May 1, 1906*)	Aug. 31, 1909
Conrad, Lowell Edwin. Prof. of Civ. Eng., Kansas State Agri. Coll., Manhattan, Kans	Oct. 3, 1906
Converse, William Hasson. Pres., Converse Bridge Co., Chattanooga, Tenn	Jan. 6, 1892
Conway, John Sebastian. Chf. Const. Engr., Bureau of Light Houses, Washington, D. C	May 4, 1909
Conzelman, John Edward. Chf. Engr., Unit Constr. Co., 1101 Liggett Bldg., St. Louis, Mo	April 4, 1906

	Date of Membership
Cook, Horace Arthur. Cons. and Constr. Engr., 31 West Adams St., Phœnix, Ariz	May 3, 1910
Cook, Paul Darwin. 701 Pierce St., Sioux City, Iowa	Jan. 31, 1911
Cooke, Frederick Hosmer. Civ. Engr., U. S. N., Bureau of Yards and Docks, Navy Dept., Washington, D. C	July 9, 1906
Cooke, George Richardson. 1109 Ford Bldg., Detroit, Mich	June 3, 1908
Cooke, Saint George Henry. Chf. Engr., West Chester & Wilmington Ry., Real Estate Trust Bldg., Philadelphia (Res., 608 Morton Ave., Ridley Park), Pa	Jan. 5, 1909
Coomer, Ross Miller. Asst. Engr. on Grade Crossing Elimination Impvt., N. Y. C. & H. R. R. R. Co. (Res., 2541 Main St.), Buffalo, N. Y	Nov. 4, 1908
Cooper, David Reginald. Secy., State Water Supply Comm., Lyon Blk. (Res., 140 Jay St.), Albany, N. Y	July 1, 1908
Cooper, Kenneth Farra. Mgr., Am. Cyanamid Co., Niagara Falls, Ont., Canada. (*Jun., Oct. 6, 1903*)	Jan. 8, 1908
Cope, Erle Long. 2318 Telegraph Ave., Berkeley, Cal. (*Jun., Jan. 7, 1908*).	Dec. 6, 1910
Copeland, Frederick Lucius. Asst. Supt., Bates & Rogers Constr. Co., 213 Lindelle Blk., Spokane, Wash. (*Jun., Nov. 5, 1907*)	Jan. 31, 1911
Copland, Alexander Chisholm. Designing Engr., C. & O. Ry., Room 30, Gen. Offices, Richmond, Va	Mar. 2, 1909
Copley, George Noble. Treas., Goedhart & Bates; Secy. and Treas., U. S. Eng. Co., 324 Security Bldg., Galveston, Tex. (*Jun., April 3, 1906*)	Oct. 5, 1909
Corby, Charles Edward. In Chg. of Drafting Room, N. Y. City Ry., 552 McDonough St., Brooklyn, N. Y	Oct. 4, 1893
Corey, Ray Howard. Asst. Engr., Water Dept., Portland, Ore	Oct. 3, 1906
Corlett, Bertram Edwin. Kenmore, King Co., Wash	May 4, 1909
Cornell, Douglas. Structural Engr. and Acting Commr., Bureau of Bldgs., Dept. of Public Works, Buffalo, N. Y	Sept. 6, 1899
Cornell, John Wesley. Asst. Div. Engr. of Tunnels and Subways for Board of Superv. Engrs., 181 La Salle St., Room 1101, Chicago, Ill.	June 30, 1910
Corning, Dudley Tibbets. M. E. and S. Dept., Cambria Steel Co., Johnstown, Pa	Oct. 1, 1902
Corrigan, George Washington. Asst. Engr., S. P. Co., 319 Ellsworth Ave., San Mateo, Cal. (*Jun., Feb. 5, 1901*)	Oct. 5, 1904
Corti, Joseph James. Casilla Correa 68, Mendoza, Argentine Republic	Jan. 1, 1896
Cother, Albert Adiel. 908 C. & N. W. Gen. Office Bldg., Chicago, Ill	April 1, 1908
Cothran, Thomas White. Greenwood, S. C	July 9, 1906
Couchot, George John. Chf. Draftsman, Bond Issue Dept., City Engr.'s Office, 1841 Green St., San Francisco, Cal	May 3, 1910
Coulson, Benjamin LeFevre. Prof. of Eng., Univ. of the South, Sewanee, Tenn	May 6, 1908
Coulter, Waldo Scarlette. Asst. Engr., Public Service Comm., First Dist., 1117 Glenwood Rd., Brooklyn, N. Y	May 6, 1908
Covell, Vernon Royce. Deputy County Engr., Court House, Pittsburg, Pa.	Mar. 7, 1906
Coverdale, William Hugh. Cons. Engr., 66 Broadway, New York City. (*Jun., Jan. 2, 1894*)	Oct. 3, 1900
Covert, Clermont C. Dist. Engr., U. S. Geological Survey, Room 18, Federal Bldg., Albany, N. Y	July 1, 1909
Cowles, Luzerne Simeon. Asst. Designing Engr., Elevated and Subway Constr., Boston Elev. Ry. Co., 101 Milk St., Boston, Mass	May 1, 1907
Cowper, John Whitfield. Vice-Pres., Worden-Allen Co., 115 Adams St., Chicago, Ill. (*Jun., June 21, 1894*)	Oct. 2, 1901
Cox, Charles Barrows. Box 127, Mabton, Wash	Sept. 6, 1910
Coyne, Harry Lewis. Asst. Engr., Public Service Comm., First Dist., 550 West 170th St., New York City. (*Jun., Feb. 5, 1907*)	June 30, 1910
Craig, George Washington. City Engr., Omaha, Nebr	Feb. 7, 1906
Craig, Joseph Edwin. Cons. Engr., Craig & Marshall, Box 181, Green Cove Springs, Fla	Nov. 8, 1909
Craig, Philip Insley. Flemington, N. J	Feb. 3, 1904
Craig, Washington Righter. Chf. Engr., Shawmut Min. Co., St. Marys, Pa. (*Jun., May 1, 1894*)	Oct. 1, 1902
Crain, Arthur Manchester. 1012 Fulton St., Elkhart, Ind. (*Jun., Jan. 3, 1907*)	Dec. 1, 1908
Crane, Joseph Spencer. Engr. and Contr. (Walter E. Isetts & Co.), (Res., 668 Clifton Ave.), Newark, N. J. (*Jun., Dec. 5, 1905*)	Nov. 4, 1908
Crawley, Ernest Willard. U. S. Junior Engr., 407 First National Bank Bldg. (Res., 299 Norton St.), New Haven, Conn. (*Jun., May 31, 1904*).	Sept. 6, 1910
Creelman, Charles Lauder. 613 Bankers Trust Bldg., Tacoma, Wash.	Mar. 4, 1908
Crisp, Ernest John. 1212 Middle Ave., Elyria, Ohio. (*Jun., Oct. 31, 1905*)	April 1, 1908
Crook, John Anthony. Proprietor, Monarch Eng. Co.; Pres., Monarch Constr. Co., Falls City, Nebr. (*Jun., Feb. 3, 1903*)	Dec. 1, 1908
Crosby, Hewitt. With Post & McCord, 44 East 23d St., New York City	Oct. 5, 1909
Crosett, James Haven. Engr. and Gen. Mgr., Visalia Elec. R. R. Co., P. O. Box D, Exeter, Cal	Jan. 4, 1905
Crow, Edward. Eng. School, Wanganui, New Zealand. (*Jun., Oct. 3, 1905*)	June 30, 1910
Crowe, Francis Trenholm. Engr. in Chg., Snake River Storage Project, U. S. Reclamation Service, Moran, Wyo	May 3, 1910

	Date of Membership
Cryder, Howard Michael. Vice-Pres., Wm. P. Carmichael Co., Engrs. and Contrs., St. Louis, Mo	June 6, 1906
Crysler, Arthur Garfield. Asst. Engr. on Barge Canal Work, 126 Shonnard St., Syracuse, N. Y	Aug. 31, 1909
Cudworth, Frank Grant. Cons. Engr. and Archt., 601 Kansas City Life Bldg., Kansas City, Mo	Jan. 3, 1900
Culgin, Guy Whitmore. Asst. Engr., Bureau of Bldgs., 220 Fourth Ave. (Res., 410 West 148th St.), New York City. (*Jun., Mar. 6, 1900*)	Sept. 7, 1904
Cummings, Elmore David. U. S. Asst. Engr., 302 Custom House, Baltimore, Md	Nov. 4, 1903
Cummings, Noah. Asst. Engr., Dept. of Bridges, City of New York, 221 West 141st St., New York City. (*Jun., Mar. 3, 1896*)	Jan. 6, 1904
Cunningham, Edward Walter. The Eastman, Detroit St., Cleveland, Ohio.	Oct. 2, 1907
Cunningham, John George Lawrence. Insp. of Bldgs., 497 Dayton Ave., St. Paul, Minn	Jan. 5, 1909
Cunningham, Stanley, Jr. Engr. for Edward Burnett & Alfred Hopkins, 11 East 24th St., New York City	Oct. 3, 1906
Curfman, Lawrence Everett. City Engr., 310 West Rose Ave., Pittsburg, Kans	Dec. 6, 1910
Currier, Albert Moore. Office Engr., Constr. Dept., L. S. & M. S. Ry., 7711 Lexington Ave., Cleveland, Ohio	May 3, 1910
Curtis, Clinton Alonzo. Asst. Engr., Dept., State Engr. and Surv., in Chg. Contract No. 54, Fort Edward, N. Y. (*Jun., Oct. 1, 1907*)	Oct. 5, 1909
Curtis, Varnum Pierce. Cons. Engr. and Contr., 96 Stafford St., Worcester, Mass	Dec. 7, 1904
Cushing, Bruce Lincoln. Engr. in Chg., Constr., Juragua Iron Co., Firmeza, Santiago de Cuba, Cuba	Oct. 4, 1910
Cutler, Alvin Sayles. Asst. Prof. of Ry. Eng., Univ. of Minnesota, Minneapolis, Minn	Feb. 1, 1910
Cutting, George Warren, Jr. Civ. and Hydr. Engr., National Bank Bldg., Waltham, Mass	May 3, 1910
Daggett, Fred Wallis. 1010 Paddock Bldg., Boston, Mass	May 1, 1907
Dalrymple, Francis Wharton. City Engr., Bayonne, N. J	Feb. 7, 1894
Daly, David Augustus. With Johnson & Carey Co., R. R. Contrs., 312 Hockney Bldg., St. Paul, Minn	May 31, 1910
Dambach, William Nicholas. Junior Engr., U. S. Engr. Office, Wheeling, W. Va	Sept. 6, 1910
Daniels, Mark Roy. Civ. and Hydr. Engr., 517 Monadnock Bldg., San Francisco, Cal	Nov. 4, 1908
Daniels, Thomas Remington Holden. Engr., Terre Haute, Indianapolis & Eastern Traction Co., 703 Traction Terminal Bldg., Indianapolis, Ind.	Feb. 6, 1907
Darling, John Whitson. Asst. Engr., N. Y. C. & H. R. R. R. Co., 145 Washington St., Buffalo, N. Y	June 7, 1905
Darrow, Marius Schoonmaker. Chf. Engr., Irrigated Lands Co., 508 Newhouse Blk., Salt Lake City, Utah. (*Jun., Feb. 6, 1900*)	Dec. 1, 1908
Darrow, Wilton Joseph. Cons. Engr. (Balcom & Darrow), 314 Madison Ave., New York City	Nov. 1, 1905
Darwin, Walton Pruett. Care, Superv. Archt., U. S. Treasury Dept., Washington, D. C	Feb. 6, 1907
Dater, Philip Herrick. Res. Engr., Barge Canal, Little Falls, N. Y	April 5, 1905
Daugherty, Henry Michael. Constr. Supt., J. G. White & Co., Crane Val. Dam, North Fork, Madera Co., Cal	May 6, 1908
Davenport, James Watson. Chf. Engr., Bonhomie South-Western R. R., Hattiesburg, Miss	Nov. 30, 1909
Davies, William Gomer. Willows, Cal. (*Jun., Feb. 2, 1904*)	Nov. 8, 1909
Davis, Benjamin Herman. Cons. Engr., Metropolitan Bldg., New York City.	Nov. 30, 1909
Davis, Fred Carnot. Civ. and Hydr. Engr. (Pratt & Davis), 117 Main St., Fitchburg, Mass	Oct. 7, 1908
Davis, Fred Rufus. Bullville, Orange Co., N. Y	Nov. 5, 1902
Davis, Frederick. Asst. Supt., Santa Cruz Portland Cement Co., Davenport, Cal	Oct. 4, 1905
Davis, George Jacob, Jr. Asst. Prof. of Hydr. Eng., Univ. of Wisconsin, 1731 Regent St., Madison, Wis. (*Jun., Nov. 4, 1902*)	Oct. 2, 1907
Davis, George Robert. Topographer, U. S. Geological Survey, Washington, D. C	April 3, 1907
Davis, Gilbert Louis. Supt. of Irrig., U. S. Reclamation Service, Ridgelawn, Mont	Mar. 4, 1908
Davis, Harold. Union Trust Bldg., Washington, D. C	Oct. 2, 1901
Davis, James Lyford. Asst. Engr., Board of Water Supply, City of New York, Bryn Mawr Park, Yonkers, N. Y	May 4, 1904
Davis, John Charles. Dean of Coll. of Applied Science and Eng., Marquette Univ., Milwaukee, Wis	July 1, 1909
Davis, William Russell. Chf. Bridge Designer and Insp., Office of State Engr. of New York, 6th Floor, De Graaf Bldg., Albany, N. Y.	May 2, 1900

	Date of Membership
Davoud, Vahram Yettvart. Elec. Engr., The Telluride Power Co., Provo, Utah	July 1, 1909
Day, Edward Bliss. Pres., Federal Lumber Co., Blaine, Wash	Feb. 4, 1903
Day, Warren French. Asst. Engr. with James A. Green, 226 La Salle St., Chicago, Ill	Dec. 6, 1910
Day, William Peyton. Asst. Engr., John B. Leonard, 344 North Willard St., San Francisco, Cal. (*Jun., Mar. 6, 1906*)	Mar. 1, 1910
Deacon, Ernest Franklin. Chf. Engr., Virginia Southern R. R., Abingdon, Va	July 10, 1907
Dean, Stanley. Instr. in Dept. of Civ. Eng., Armour Inst. of Tech. (Res., 7217 Perry Ave.), Chicago, Ill	April 1, 1908
DeBerard, Wilford Willis. Western Editor, *Engineering Record,* 1570 Old Colony Bldg., Chicago, Ill	May 2, 1906
Decker, John Hull. Chf. Engr. and Gen. Mgr., Atlantic Constr. & Supply Co., 232 Bartlett Bldg., Atlantic City, N. J. (*Jun., Sept. 6, 1904*)	Dec. 5, 1906
DeGraff, Harry Westbrook. 1 McClellon Ave., Amsterdam, N. Y	Jan. 3, 1906
de Gratresse, Joseph Reygondeau. 612 West 115th St., New York City.	Jan. 2, 1907
De La Mater, Stephen Truesdell. Estimator, 807 Security Bldg., Chicago, Ill	Nov. 4, 1908
Demorest, George Myron. Engr., Canton Plant, Am. Bridge Co., Canton, Ohio	June 30, 1910
DeMott, Charles Leonard. 47 Law Bldg., Lynchburg, Va	June 6, 1906
Dempster, Osborne Joel. City Engr., Little Falls, N. Y	Jan. 3, 1906
Dennis, Harry Whiting. Constr. Engr., Southern California Edison Co., Los Angeles, Cal	Oct. 2, 1907
Dent, Elliott Johnstone. Capt., Corps of Engrs., U. S. A., Vancouver Barracks, Vancouver, Wash	May 1, 1907
Dent, Walter Devere. Care, J. E. Sirrine, Greenville, S. C	Nov. 8, 1909
Derby, Chester Cawthorne. Chf. Draftsman, Dept. of Yards and Docks, Navy Yard, New York, 50 Elm St., Richmond Hill, N. Y	May 4, 1909
Derr, Homer Munro. Prof. of Civ. Eng., South Dakota State Coll., and Asst. Engr., South Dakota R. R. Comm., Brookings, S. Dak	Jan. 4, 1910
Derrick, Clarence. 53 Beechwood Ave., Trenton, N. J	Oct. 4, 1910
Devlin, Henry Stratford. Office, Westinghouse, Church, Kerr & Co., 10 Bridge St., New York City (Res., 349 Clinton St., Brooklyn, N. Y.)	June 5, 1907
de Vou, James Laird. Asst. Engr., Erecting Dept., Am. Bridge Co. of N. Y., Room 1530, Frick Bldg., Pittsburg, Pa	April 1, 1903
Diamant, Arthur Herbert. Engr., Blaw Collapsible Steel Centering Co., Westinghouse Bldg., Pittsburg, Pa. (*Jun., May 5, 1903*)	Dec. 5, 1906
Dicke, Edward Christian. 4670 Gibbons St., St. Louis, Mo. (*Jun., May 3, 1904*)	April 6, 1909
Dickerson, John Thomas. Asst. Engr., Sales Dept., Scherzer Rolling Lift Bridge Co., 1616 Monadnock Bldg., Chicago, Ill	April 5, 1910
Dickinson, William Dewoody. State Bank Bldg., Little Rock, Ark	May 3, 1910
Dieck, Robert George. 614 Corbett Bldg., Portland, Ore	Nov. 6, 1907
Dieden, Gotthard Vincent. Cons. Engr., 47 Stortorget, Malmo, Sweden	Oct. 2, 1907
Diehl, David Leslie. Secy. and Treas., The Lewisburg, Milton & Watsontown Pass. Ry.; (Whittaker & Diehl and Ferro Concrete Co.), Harrisburg, Pa	Jan. 5 1909
Dietrich, William Henry. Res. Engr., U. S. Steel Products Export Co., 24a Kiangse Rd., Shanghai, China	Jan. 4, 1910
Dilks, Lorenzo Carlisle. Contr. Mgr., The Eastern Steel Co., 71 Broadway, New York City	Jan. 3, 1906
Dillard, John Lea. Gen. Mgr., The Sturm & Dillard Co., Blountsville, Ind.	June 1, 1904
Dillon, Francis Henry. P. O. Box 454, San Antonio, Tex	Oct. 3, 1900
Dingle, James Hervey. City Engr., Charleston, S. C. (*Jun., April 30, 1895*)	Oct. 4, 1899
Dixon, De Forest Halsted. Second Vice-Pres., Turner Constr. Co., 11 Broadway, New York City (Res., 27 Grace Court, Brooklyn, N. Y.). (*Jun., May 3, 1898*)	Feb. 3, 1904
Dodd, Albert Beeston. Address unknown	Sept. 5, 1906
Dodd, John Hugh. Jamaica Govt. Ry., Kingston, Jamaica	Mar. 6, 1907
Dodge, Samuel Douglass. Asst. Engr., Board of Water Supply of City of New York, Cornwall-on-Hudson, N. Y	Nov. 6, 1907
Doebler, Valentine Sherman. Supt., Transportation, Cam. Steel Co., Johnstown, Pa	Dec. 6, 1893
Donahey, Joseph Alexander. Contr. Engr., Bridgeport, Ohio	Dec. 4, 1907
Donald, Robert L'Amy. Cons. Engr., Failing Bldg., Portland, Ore	May 1, 1907
Donovan, Daniel Bartholomew. Asst. Engr., New York State Barge Canal, 502 N. Madison St., Rome, N. Y	Nov. 8, 1909
Dorrance, William Tully. Dist. Engr., N. Y. C. & H. R. R. R. Co., Union Station, Albany, N. Y	Sept. 4, 1901
Dorsey, Leander. Supt., Whiting-Middleton Constr. Co., Sexton Bldg., Baltimore, Md	Oct. 4, 1905
Dorsey, William Henry. Engr. and Mgr., Sanford & Brooks Co., 24 Commerce St., Baltimore, Md	June 5, 1907
Doten, Leonard Smith. Civ. Engr., War Dept. (Res., 410 A St., N. E.), Washington, D. C	July 9, 1906

	Date of Membership
Doty, John Williams. With The Foundation Co., 115 Broadway, New York City. (*Jun., Nov. 3, 1903*)	Jan. 4, 1905
Dougan, James. Engr. with Clinton & Russell, 32 Liberty St., New York City. (*Jun., Mar. 5, 1901*)	Mar. 2, 1904
Dow, William Grear. Chf. Engr., Eden Irrig. & Land Co., Eden, Wyo	Dec. 6, 1910
Downer, Thomas Benson. Chf. Engr., San Diego Constr. Co., 1117 D St., San Diego, Cal	Oct. 2, 1907
Downes, Alfred Kimball. Box 509, Monroe, La	Feb. 3, 1904
Downman, Julian Romney. 2022 N St., N. W., Washington, D. C	Dec. 4, 1901
Doying, William Albert Edward. Insp. Engr., Isthmian Canal Comm. (Res., 1657 Lamont St., N. W.), Washington, D. C	Feb. 1, 1910
Doyle, Henry Sisson. Gen. Mgr., Reinforced Concrete Dept., Am. Steel & Wire Co., Chicago, Ill	Jan. 8, 1908
Drake, Robert Morris. Dist. Engr., S. P. Co., Room 1052, Flood Bldg., San Francisco, Cal	Mar. 7, 1900
Drane, Brent Skinner. 1118 Realty Bldg., Charlotte, N. C	July 10, 1907
Drew, Charles Davis. With J. G. White & Co., Ltd., 9 Cloak Lane, London, E. C., England	Oct. 7, 1903
Drowne, Henry Bernardin. Asst. Engr., Rhode Island State Board of Public Roads; Instr. in Civ. Eng., Brown Univ., Box 3, East Side Station, Providence, R. I. (*Jun., Sept. 5, 1905*)	Mar. 4, 1908
Du Bois, Julian. Gen. Mgr., Compañia Electrica de Concepcion, Concepcion, Chili	Jan. 8, 1902
Duder, John. Chf. Engr., The Birch Co., P. O. Box 786, Salt Lake City, Utah	Nov. 8, 1909
Dufour, Frank Oliver. Asst. Prof. of Structural Eng., Univ. of Illinois, Urbana, Ill. (*Jun., Dec. 5, 1899*)	Oct. 1, 1902
Duncan, Dorsey Berry. 1305 Windsor St., Columbia, Mo	May 31, 1910
Duncan, James Harper. Civ. Engr. and Surv., Searsport, Me. (*Jun., Dec. 4, 1906*)	Feb. 1, 1910
Dunglinson, George, Jr. Care, Allotment Commr., Norfolk & West. Ry. Co., Bluefield, W. Va	Nov. 1, 1910
Dunlop, Samuel Campbell. Asst. Engr., Charleston Sewer System, Office, City Engr., Charleston, S. C	Dec. 6, 1910
Dunn, Emmett Clarke. City Engr., Alexandria, Va	Nov. 4, 1891
Dunn, Herbert Luther. 172 Willetts Ave., New London, Conn	Nov. 1, 1905
Dunn, Oswald Thorpe. Asst. Engr., Ill. Cent. R. R., Water Valley, Miss.	Sept. 6, 1910
Dunn, William Robert. Civ. Engr. and Works Mgr., Vulcanite Portland Cement Co., Easton, Pa	April 6, 1904
Dunnells, Clifford George. Head Instr. in Dept. of Mechanism and Materials, School of Applied Industries, Carnegie Technical Schools, Pittsburg, Pa. (*Jun., Feb. 4, 1902*)	Jan. 2, 1907
Dutton, Charles Henry. Care, J. R. Worcester & Co., Waltham, Mass	Jan. 8, 1908
Dygert, Harry Isaiah. 2623 Ashby Ave., South Berkeley, Cal	May 3, 1910
Easterbrooks, Preston Burt. Care, Westinghouse, Church, Kerr & Co., 10 Bridge St., New York City	May 1, 1907
Ebashi, Teiji. Care, Corrugated Bar Co., St. Louis, Mo	Oct. 4, 1910
Eberly, Clarence Frederick. Asst. Topographer, U. S. Geological Survey, Washington, D. C	Sept. 6, 1910
Eddy, Charles Wells. Res. Engr., Waterbury Water Supply, Thomaston, Conn	Mar. 2, 1909
Edelen, Thomas Jefferson Stone. Suite 28, Preston Court, Winnipeg, Man., Canada	July 1, 1909
Eder, Henry James. Cali, Colombia. (*Jun., June 5, 1894*)	Sept. 1, 1897
Edwards, Charles Milton. First Asst. Engr., New York State Dept. of Highways, Kirstein Bldg., Rochester, N. Y	Sept. 2, 1908
Edwards, Dean Gray. Asst. Engr., New York Board of Water Supply, Walden, N. Y. (*Jun., Nov. 1, 1904*)	Feb. 1, 1910
Edwards, Frederick. 369 Congress St., Troy, N. Y. (*Jun., Jan. 31, 1899*).	Feb. 5, 1902
Edwards, Harold. 702 Builders Exchange, Winnipeg, Man., Canada	Sept. 6, 1910
Edwards, Llewellyn Nathaniel. P. O. Box 362, Montreal, Que., Canada	Mar. 1, 1910
Edwards, Oliver Cromwell, Jr. Pres., The Pneumatic Caisson Co., Room 1000, Fifth Ave. Bldg., New York City (Res., 345 St. John's Pl., Brooklyn, N. Y.). (*Jun., Oct. 7, 1902*)	Dec. 5, 1906
Egan, Louis Henry. Gen. Mgr., Rochester Light & Power Co., Rochester, Mich	Oct. 5, 1909
Egbert, Warren. 805 McDonald Ave., Santa Rosa, Cal	Nov. 1, 1910
Ehrbar, Louis Harvey. Engr., Subway Constr., Plant Dept., N. Y. Telephone Co., 15 Dey St., New York City	May 2, 1906
Eitzen, Arthur Robert. 23d and Grand Ave., Kansas City, Mo. (*Jun., Sept. 6, 1904*)	Nov. 1, 1910
Elbury, Thomas George. Municipal Engr. and Contr., 552 Pacific Bldg., San Francisco, Cal	May 6, 1908
Eld, Charles John, Jr. 3709 Windsor Pl., St. Louis, Mo	May 6, 1903

	Date of Membership
Elliott, John Stuart. Civ. and Min. Engr., 29 Broadway, New York City.	April 6, 1892
Elliott, Malcolm. Junior Engr., U. S. Engr. Office, Louisville, Ky. (*Jun., Nov. 5, 1907*)	April 6, 1909
Ellis, Charles Alton. Asst. Prof. of Civ. Eng., Univ. of Michigan; Bridge Engr., 916 Church St., Ann Arbor, Mich	April 3, 1907
Ellis, Guernsey William. Designing Engr., Turner Constr. Co., 312 Prudential Bldg., Buffalo, N. Y	Nov. 4, 1908
Elrod, Henry Exall. Gen. Mgr., Union Iron Works, Houston, Tex	Nov. 7, 1906
Ely, Carl Brandes. Asst. to Supt., B. and C. Dept., Pennsylvania Steel Co., Steelton, Pa	April 3, 1907
Ely, John Andrews. Structural Engr., 90 Morningside Ave., W., New York City. (*Jun., April 30, 1901*)	Jan. 8, 1908
Ely, John Stanton. Engr. in Chg., Queen Lane Filter Plant, Germantown, Philadelphia, Pa	Mar. 2, 1904
Emerson, George Dana. Asst. Engr., Boston Transit Comm., 15 Beacon St., Boston, Mass	June 3, 1908
Emerson, Raffe. Asst. to Gen. Mgr., Lehigh Val. R. R., Bethlehem, Pa.	June 30, 1910
Engle, Charles Algernon. 715 South Hope St., Los Angeles, Cal. (*Jun., May 5, 1908*)	Oct. 5, 1909
Engström, Frans. City Engr., Altoona, Pa	May 4, 1892
Ensey, Richard Fahnestock. County Engr., Putnam County, Palatka, Fla.	April 5, 1910
Enzian, Charles. Min. Engr., U. S. Bureau of Mines (Res., 375 South River St.), Wilkes-Barre, Pa. (*Jun., Sept. 3, 1901*)	Mar. 1, 1905
Espenshade, Edward Bowman. Asst. Engr., The Dolese Shephard Co. (Res., 6354 Greenwood Ave.), Chicago, Ill	Nov. 6, 1907
Estes, Franklin Edward. Stilwell, Okla	Feb. 7, 1906
Etcheverry, Bernard Alfred. Agri. Bldg., Univ. of California, Berkeley, Cal	June 1, 1909
Evans, John Edward. Asst. Engr., Detroit River Tunnel Co., 413 Maple St., Ypsilanti, Mich	Nov. 8, 1909
Evans, John Maurice. Treas., Cooper & Evans Co., Gen. Contrs., 220 Broadway, New York City. (*Jun., May 4, 1897*)	Jan. 3, 1900
Evans, Peter Platter. Secy., The Osborn Eng. Co., Cleveland, Ohio. (*Jun., Feb. 6, 1894*)	Mar. 7, 1900
Everham, Arthur Cassidy. Div. Engr., Kansas City Terminal Ry., 23d and Grand Ave., Kansas City, Mo. (*Jun., Feb. 6, 1906*)	June 5, 1907
Ewald, Robert Franklin. Asst. Engr., U. S. Reclamation Service, Provo, Utah	Jan. 3, 1911
Fain, James Rhea. Supt. of Constr., U. S. Public Bldgs., Harriman, Tenn.	June 4, 1902
Fairchild, John Fletcher. Engineering Bldg., Mt. Vernon, N. Y. (*Jun., April 5, 1892*)	Dec. 4, 1895
Falter, Philip Henry. Gen. Supt., Northern Aluminum Co., Ltd., Shawinigan Falls, Que., Canada	Mar. 7, 1906
Farley, William Sanborn. Gen. Contr. (Scott & Farley), 48 Bacon Bldg., Oakland, Cal	Nov. 8, 1909
Farnham, Arthur Benjamin. Engr., Board of Public Works, Pittsfield, Mass.	Jan. 2, 1907
Farnham, Charles Henry. 18 Cedar St., Beverly, Mass	June 1, 1904
Farquhar, Henry Stilson. Gen. Mgr. and Chf. Engr., Philadelphia & Western Ry. Co., Upper Darby, Pa. (*Jun., April 5, 1892*)	Nov. 4, 1896
Farrin, James Moore. Engr. of Bridges and Bldgs., Cuba R. R., Camagüey, Cuba	Nov. 30, 1909
Federlein, Walter Gottlieb. Asst. Engr., Rapid Transit Subway Constr. Co., 266 West 95th St. (Res., 611 West 127th St.), New York City. (*Jun., Jan. 2, 1906*)	Feb. 2, 1909
Fenkell, Neal Charles. Engr., Smith, Hinchman & Grylls, 228 Baldwin Ave., Detroit, Mich	Dec. 1, 1908
Fenstermaker, DeWitt Clinton. Asst. Engr., L. & N. E. R. R., Room 29, Navigation Bldg., Mauch Chunk, Pa	Jan. 8, 1908
Fenton, Louis Gillespie. Asst. Engr. Designer, Board of Water Supply, 299 Broadway, New York City	Feb. 1, 1905
Ferguson, Lewis Repp. Prof. of Math., Temple Univ.; Cons. Engr., 1330 Land Title Bldg., Philadelphia, Pa. (*Jun., Aug. 31, 1909*)	Jan. 31, 1911
Ferguson, William Hastings. P. O. Box 479, Prince Rupert, B. C., Canada.	Jan. 7, 1903
Ferradas, Ramiro. Care, Sociedad de Ingenieros, Lima, Peru. (*Jun., Jan. 3, 1905*)	Mar. 7, 1906
Ferris, Frederick Edward. Asst. Engr., R. T. R. R. Comm., 231 West 125th St., New York City (Res., 820 Montgomery St., Jersey City, N. J.).	June 1, 1898
Fertig, Jerome Henry. Asst. Engr., U. S. Reclamation Service, Montrose, Colo. (*Jun., Oct. 2, 1906*)	Mar. 1, 1910
Fineren, William Warrick. Junior U. S. Engr., U. S. Engr. Office, Federal Bldg., Tampa, Fla	Oct. 5, 1909
Firth, Elmer Wallace. Asst. Engr., Bureau of Sewers, Borough of Queens, New York City (Res., 1 John St., Jamaica, N. Y.). (*Jun., Jan. 7, 1896*)	Nov. 7, 1906

	Date of Membership
Firth, Joseph. City Engr., Charlotte, N. C.	June 5, 1907
Fischer, Guillermo Gustavo. Chf. Engr., Public Works of the Provincial Govt., Santa Clara, Cuba. (*Jun., Feb. 2, 1904*)	Dec. 6, 1910
Fischer, Theodore Christian. 1018 E. Grand St., Elizabeth, N. J.	Dec. 4, 1907
Fisher, Chester Centennial. Asst. Engr., U. S. Reclamation Service, Boise, Idaho. (*Jun., April 3, 1906*)	Oct. 2, 1907
Fisher, Howell Tracy. 5235 Archer St., Germantown, Philadelphia, Pa.	Nov. 1, 1905
Fisher, Wager. Civ., Elec. and Mech. Engr., 1516 Commonwealth Bldg., Philadelphia, Pa. (*Jun., Oct. 3, 1899*)	Nov. 6, 1907
Fisher, Wilbur Howard. Res. Engr., City Engr.'s Office, Spokane, Wash. (*Jun., Dec. 6, 1904*)	Nov. 30, 1909
Fisk, Andrew Jackson, Jr. Asst. Engr., U. S. Reclamation Service, St. Ignatius, Mont.	Nov. 30, 1909
Fisk, Clinton Hinckley. Chf. Engr., Tennessee, Alabama & Georgia R. R. Co., 1021 James Bldg., Chattanooga, Tenn.	June 5, 1907
Fitch, Squire Earnest. Asst. Engr., Dept. of Highways, Falconer, N. Y.	July 9, 1906
FitzGerald, Christopher Columbus. Chf. Engr., T. L. Huston Contr. Co., Zulueta 46, Havana, Cuba	Oct. 2, 1901
Fitzgerald, Walter Lewis. Designing Engr., Sellers & Rippey; Cons. Engr., 1416 Rush St., Philadelphia, Pa.	May 3, 1910
Fitzpatrick, James Raymond. Gen. Mgr., Grand Rapids Hydr. Co., 106 Michigan Trust Bldg., Grand Rapids, Mich.	May 31, 1910
FitzRandolph, William Sheppard. (Bang & FitzRandolph), 34th St. and Broadway, New York City. (*Jun., April 3, 1906*)	Sept. 6, 1910
Fleming, Thomas, Jr. (Chester & Fleming, Hydr. and San. Engrs.), Union Bank Bldg., Pittsburg, Pa. (*Jun., Nov. 5, 1907*)	Oct. 5, 1909
Fletcher, Josiah Monk. Richmond, Jamaica	Oct. 4, 1905
Focht, Louis. Engr. to State Board of Assessors; Cons. Engr., 12 Atterbury Ave., Trenton, N. J.	May 4, 1892
Fogg, Percival Morris. Engr., U. S. Reclamation Service, Rupert, Idaho.	Nov. 6, 1907
Follansbee, Robert. Dist. Engr., U. S. Geological Survey, St. Paul, Minn. (*Jun., Nov. 1, 1904*)	Oct. 7, 1908
Foote, Arthur Burling. Asst. Supt., North Star Mines Co., Grass Valley, Cal.	Mar. 1, 1905
Forbes, Murray. Greensburg, Pa.	June 5, 1907
Forchhammer, Herluf Trolle. Chf. Engr., Christiani & Willsen Co., Contrs., Aarhus, Denmark	Feb. 1, 1905
Ford, Harry Clifford. Chf. Engr., Rodgers & Hagerty, Gen. Contrs., 417 West 150th St., New York City. (*Jun., Mar. 6, 1906*)	Feb. 1, 1910
Ford, Howard Carlton. Asst. Prof. of Irrig. Eng. and Surv., Iowa State Coll., Ames, Iowa. (*Jun., Sept. 1, 1908*)	May 31, 1910
Ford, Robert Henry Persse. Asst. to Chf. Engr., M. of W., Missouri Pacific-Iron Mountain Systems, Title Guarantee Bldg., St. Louis, Mo. (*Jun., Mar. 2, 1897*)	June 7, 1899
Ford, William Ellis. (Ford & MacCrea), Room 223, Gazette Bldg., Little Rock, Ark.	Mar. 1, 1910
Forrest, Charles Needham. Maurer, N. J.	April 6. 1909
Forrest, George Munro. 280 Broadway, Room 259, New York City	Oct. 2, 1907
Fortney, Camden Page. Supervisor of Masonry, Gatun Locks, Gatun, Canal Zone, Panama. (*Jun., Oct. 2, 1906*)	Nov. 30, 1909
Foss, John Harrison. Instr., Civ. Eng. Dept., Leland Stanford Jr. Univ., P. O. Box 65, Palo Alto, Cal. (*Jun., Dec. 1, 1903*)	Oct. 4, 1910
Foster, Mortimer. 15 West 38th St., New York City	June 1, 1904
Foster, Thomas J. 1123 Broadway, New York City	Feb. 1, 1899
Fougner, Hermann. Civ. Engr. and Agt., Trussed Concrete Steel Co., 25 Madison Sq., North, New York City	Feb. 1, 1905
Fouilhoux, Jacques André. Cons. Engr., Whitehouse & Fouilhoux, Archts., Portland, Ore.	Oct. 5, 1909
Fountain, Thomas Lilly. Civ. and San. Engr., The Fountain-Shaw Eng. Co., 308 Andrews Bldg., Dallas, Tex. (*Jun., April 2, 1907*)	April 6, 1909
Fowler, Frank George. Civ. Engr. and Contr., Mt. Kisco, N. Y.	June 5, 1907
Fowler, Robert Lambert. Mgr., Barber Asphalt Paving Co., Maurer, N. J.	Feb. 2, 1909
Fox, Walter Gordon. Ingeniero Residente, Ferrocarril Mexicano del Sur; Cons. Engr., Ferrocarril al Curaray, Hotel Alameda, Oaxaca, Mexico.	Jan. 2, 1901
Foyé, Andrew Ernest. Pres., Andrew E. Foyé Co., 20 Broad St., New York City. (*Jun., May 2, 1893*)	Nov. 4, 1896
Frasquieri y Regueifero, Tranquilino. Ingeniero de Caminos, Canales y Puertos, San Lazaro 101, Havana, Cuba	Aug. 31, 1909
Frazee, John Hatfield. 516 West 183d St., New York City	Dec. 6, 1899
Freeman, Arthur Clarico, Jr. 239 Arcade Bldg., Norfolk, Va.	July 1, 1908
Freeman, Milton Harvey. Asst. Engr., Board of Water Supply, New York City, Stone Ridge, Ulster Co., N. Y.	July 1, 1909
Freitag, Joseph Kendall. Secy., A. B. Robbins Iron Co., Norfolk Downs, Quincy, Mass.	Jan. 3, 1900
French, Charles Rauch. Engr. for Herrick Constr. Co., Wilkes-Barre, Pa.	Oct. 7, 1908

	Date of Membership
FRENCH, MANSFIELD JOSEPH. Engr., M. of W., Utica & Mohawk Val. Ry. Co.; Engr., M. of W., Oneida Ry. Co., Electric Railway Bldg. (Res., 906 Sunset Ave.), Utica, N. Y.	July 9, 1906
FREW, ARCHIBALD JOHN RUSSELL. Engr. in Chg. of Constr. of Sec. of The Chillagoe Etheredge Ry., Malloy, North Queensland, Australia	Oct. 5, 1909
FREW, ROBERT DICKSON ALISON. Chelmer, near Brisbane, Queensland, Australia	June 1, 1898
FREY, FRANK EDWARD. Engr. and Contr., 820 Georgia St., Vallejo, Cal.	Oct. 3, 1906
FRICK, WALTER. Lewisburg, Union Co., Pa	Dec. 2, 1896
FRICKSTAD, WALTER NETTLETON. 1409 Tenth Ave., Oakland, Cal	June 5, 1907
FRINK, FRED GOODRICH. Prof., Railway Eng., Univ. of Oregon, Eugene, Ore.	May 3, 1899
FRISELL, ERIC HJALMAR. Contr. Engr. with Milliken Bros., Inc., 468 West 145th St., New York City	June 5, 1907
FROST, GEORGE SHERMAN. Asst. Engr., Public Service Comm. for the First Dist., State of New York, 23 Flatbush Ave., Brooklyn, N. Y. (*Jun., April 2, 1901*)	Jan. 7, 1903
FRUIT, JOHN CLYDE. Contr. Agt., Am. Bridge Co. of New York, Commercial National Bank Bldg., Chicago, Ill. (*Jun., May 2, 1905*)	Dec. 4, 1907
FRYE, HARLEY EDGAR. U. S. Engr. Office, Zanesville, Ohio	June 1, 1909
FUCIK, EDWARD JAMES. Engr., Great Lakes Dredge & Dock Co., Chicago, Ill.	Oct. 2, 1907
FULLER, ANDREW DANIEL. Treas., Andrew D. Fuller Co., Contrs. and Engrs., 3 Hamilton Pl., Boston, Mass. (*Jun., Dec. 6, 1898*)	Jan. 6, 1904
FULLER, CARL HAMILTON. Supt. and Engr., Cook Constr. Co., 518 Good Blk., Des Moines, Iowa. (*Jun., Mar. 5, 1901*)	Feb. 3, 1904
FULLER, WESTON EARLE. (Hazen & Whipple, Cons. Engrs.), 103 Park Ave., New York City	June 7, 1905
FULWEILER, WALTER HERBERT. With Dept. of Tests, United Gas Impvt. Co. of Philadelphia, Rose Valley, Moylan, Pa	Nov. 1, 1910
FURLOW, FELDER. Asst. Engr., Southern Ry., 1240 Maplewood St., Birmingham, Ala	April 6, 1909
GALBREATH, WILLIAM OTTO. Div. Engr., National Railways of Mexico, Calle Reforma No. 154, Monterey, Mexico	April 6, 1904
GANDOLFO, JOSEPH HARRINGTON. Civ. Engr. with J. G. White & Co., 43 Exchange Pl., New York City	Oct. 2, 1907
GANNETT, FARLEY. Engr., Water Supply Comm. of Pennsylvania, Harrisburg, Pa	April 4, 1906
GARDNER, RANDALL DUNBAR. Asst. Engr., Room 60, City Hall, Boston, Mass	May 1, 1907
GARMAN, HARRY OTTO. Associate Prof., Civ. Eng., Purdue Univ., Lafayette, Ind. (*Jun., Feb. 28, 1905*)	Oct. 7, 1908
GARRIGUES, HENRY HAYDOCK. Supervisor No. 2, Allegheny Div., P. R. R., Kittanning, Pa. (*Jun., Oct. 31, 1905*)	June 30, 1910
GARTENSTEIG, CHARLES. Engr. of Design, Office of Pres., Borough of the Bronx, 177th St. and 3d Ave. (Res., 61 East 83d St.), New York City. (*Jun., Oct. 6, 1896*)	May 6, 1903
GARVER, NEAL BRYANT. Instr. in Structural Eng., Univ. of Illinois, Urbana, Ill	May 3, 1910
GAUMER, ALBERT WESLEY. Chf. Engr., Juragua Iron Co., Firmeza, Santiago de Cuba, Cuba	May 31, 1910
GAY, HOWARD SPOONER. Asst. Engr. with Vielé, Blackwell & Buck, R. D. 2, Little Falls, N. Y	Dec. 6, 1910
GAY, LEON LINCOLN. Orleans, Vt. (*Jun., Dec. 5, 1905*)	Oct. 2, 1907
GAYLER, ERNEST ROTTECK. Civ. Engr., U. S. N., Navy Yard, Charleston, S. C	April 6, 1904
GAYLORD, LAURENCE TIMMERMAN. Supt. with Atlantic, Gulf & Pacific Co., P. O. Box 756, Mobile, Ala	Nov. 4, 1908
GEARHART, WALTER SCOTT. Highway Engr., Manhattan, Kans	June 3, 1908
GEHRING, HERBERT AUGUST. Asst. Engr., Bureau of Hydraulics, New York State Barge Canal Office, Albany, N. Y	May 3, 1910
GELLATLY, JOHN THOMPSON BISSET. Res. Engr., Smartt Syndicate Irrig. Works, Britstown, Cape Colony, South Africa	Jan. 2, 1907
GENTNER, OTTO HENRY, JR. Chf. Engr., Phila. Fireproofing Co., 1341 Arch St., Philadelphia, Pa	Nov. 4, 1908
GERSBACH, EDWARD CHARLES. Helena, Mont	June 1, 1909
GIBBS, ELBERT ALLAN. Engr. of Erection, McClintic-Marshall Constr. Co., Pittsburg, Pa. (*Jun., Mar. 6, 1906*)	July 1, 1909
GIBSON, WILLIAM LOANE. Engr. in Chg., Bolivian Branches, Antofagasta á Bolivia Ry. Co., Oruro, Bolivia	May 6, 1908
GIDEON, ABRAHAM. Supt., Water Supply and Sewers, City Hall, Manila, Philippine Islands	Sept. 3, 1902
GIFFORD, LESTER ROBINSON. 94 Porter Bldg., Memphis, Tenn. (*Jun., Mar. 3, 1896*)	Dec. 3, 1902
GILBERT, ARCHIBALD MARVINE. Asst. Engr., Twin Falls Salmon River Land & Water Co., Salmon River Dam, Rogerson, Idaho	May 4, 1909

	Date of Membership
GILBERT, GEORGE HERBERT. Care, Chf. Engr., Q. & C. Route, 133 Ingalls Bldg., Cincinnati, Ohio	June 3, 1908
GILDERSLEEVE, GEORGE SNYDER. Mgr., Sales, Eng. Dept., Trussed Concrete Steel Co. (Res., 421 Second Ave.), Detroit, Mich. *(Jun., Feb. 5, 1907)*	Aug. 31, 1909
GILES, ARTHUR LEONARD. 1299 Fair Ave., Columbus, Ohio	Oct. 4, 1905
GILES, JAMES MARVIN. Superv. Engr., Porto Rico Irrig. Service, Guayama, Porto Rico	Sept. 2, 1908
GILKEY, THOMAS ALVIN. Cons. Engr., 709 Lawrence Savings & Trust Co. Bldg., New Castle, Pa	Oct. 3, 1900
GILLEN, WALTER JOSEPH. Asst. Engr., Bureau of Public Bldgs. and Offices (Res., 824 East 169th St.), New York City. *(Jun., Oct. 31, 1905)*	July 1, 1909
GILMAN, CHARLES EDWARD. Civ. and Min. Engr. with Duryea, Haehl & Gilman, Cons. Engrs., 1314 Humboldt Bank Bldg., San Francisco, Cal. *(Jun., Oct. 6, 1903)*	Dec. 5, 1906
GODDARD, HERBERT WILLARD. Mgr. of Reinforced Concrete Dept., R. H. Howes Constr. Co., 105 West 40th St., New York City. *(Jun., Jan. 3, 1905)*	Jan. 5, 1909
GOLDENBERG, MAURICE. Mgr. of Sales, Trussed Concrete Steel Co., Trussed Concrete Bldg., Detroit, Mich	Feb. 7, 1906
GOLDSMITH, CLARENCE. 60 Elm St., Andover, Mass	Dec. 6, 1910
GOLDSMITH, NATHANIEL OLIVER. Care, The Weir Frog Co., Norwood, Ohio. *(Jun., June 2, 1886)*	June 6, 1900
GOODELL, JOHN STANTON. Amherst, Mass	Mar. 7, 1906
GOODMAN, JOSEPH. Asst. Engr., Dept., Water Supply, Gas and Electricity, Borough of Brooklyn, 157 West 111th St., New York City	June 6, 1906
GOODMAN, LEON. Chf. Engr., Goodman-McCormick Co., Des Moines, Iowa	June 30, 1910
GOODMAN, LOUIS. Pres., The Wormser-Goodman Constr. Co., 2 Rector St., Room 520, New York City	Oct. 5, 1909
GOODRIDGE, JOHN WESLEY. Contr. Engr., Litchfield Constr. Co., 23 Flatbush Ave., Brooklyn, N. Y. *(Jun., Oct. 4, 1898)*	April 5, 1905
GOODSELL, DANIEL BERTHOLF. 593 Riverside Drive, New York City	May 6, 1908
GOODWIN, IRVING DEAN. With Des Moines Bridge & Iron Works, 1213 Eighth St., Des Moines, Iowa. *(Jun., Dec. 3, 1907)*	Jan. 3, 1911
GORDON, JOHN BLAKE. 1410 H St., N. W., Washington, D. C. *(Jun., Dec. 1, 1903)*	June 7, 1905
GORTON, WILLARD LIVERMORE. Chf. Engr., Idaho Irrig. Co., Ltd., Richfield, Idaho	May 3, 1910
GOUGH, WILLIAM JOSEPH. Asst. Engr., Coronado Beach Co., San Diego, Cal.	Mar. 4, 1908
GOW, CHARLES RICE. Civ. Engr. and Contr., 25 Montview St., West Roxbury, Mass	June 1, 1904
GOWEN, SUMNER. Asst. Engr., Phœnix Bridge Co., Phœnixville, Pa. *(Jun., May 2, 1899)*	June 4, 1902
GRADY, JOHN EDWARD. Engr., Lake Erie Div., Great Lakes Dredge & Dock Co., 1486 E. 116th St., Cleveland, Ohio	Dec. 6, 1905
GRAHAM, EDGAR MILLER. Cons. Engr., Muskogee, Okla	Oct. 5, 1909
GRAM, LEWIS MERRITT. Structural Engr., 1047 Spitzer Bldg., Toledo, Ohio.	June 1, 1909
GRANT, JOHN ROBERT. 503 Cotton Bldg., Vancouver, B. C., Canada	Jan. 3, 1911
GRANT, JOSEPH ALEXANDER. Care, Peter Lyall & Sons, Ltd., Board of Trade Bldg., Montreal, Que., Canada	May 31, 1910
GRANT, KENNETH CROTHERS. Asst. Engr., Pittsburg Flood Comm., 1804 Arrott Bldg., Pittsburg, Pa	Feb. 2, 1909
GRANT, THOMAS HENRY. Red Bank, N. J	May 6, 1891
GRANT, ULYSSES S, 3RD. 1st Lieut., Corps of Engrs.; Supt., State, War and Navy Bldg., Washington, D. C	Aug. 31, 1909
GRAVELLE, ALVIN. Asst. Bridge Engr., 311 City Hall, Cleveland, Ohio	Nov. 6, 1901
GRAVES, WILLARD FRANKLIN. 4563 Woodlawn Ave., 3d Aprt., Chicago, Ill. *(Jun., Oct. 31, 1899)*	Jan. 4, 1905
GRAY, EDWARD. 622 Chemical Bldg., St. Louis, Mo	May 1, 1907
GRAY, EDWARD, JR. Asst. Engr., C. & O. Ry. Co., Newport, Ky	Jan. 2, 1895
GRAY, HARRY WOY. Asst. Prof. in Experimental Civ. Eng., Iowa State Coll., Ames, Iowa	Nov. 1, 1910
GRAY, HENRY LILBURN. Engr., R. R. Comm. of Washington, Olympia, Wash.	July 1, 1909
GRAY, JOHN LATHROP. Supt., Paraffine and Lubricating Dept., Tide Water Oil Co., Bayonne (Res., 35 De Witt Rd., Elizabeth), N. J	Dec. 6, 1905
GRAY, WALTER THOMAS. Engr. of Constr., Sewer Dept. (Res., 6908 Virginia Ave.), St. Louis, Mo	Oct. 7, 1908
GRAY, WILLIAM. Asst. Engr., Bureau of Sewers, Borough of Bronx, New York City. *(Jun., May 2, 1888)*	Mar. 1, 1893
GRAY, WILLIAM BACON. Gen. Mgr. and Chf. Engr., Geo. N. Jackson, Inc., Yonkers (Res., Stone Ridge), N. Y	Aug. 31, 1909
GRAY, WILLIAM DAVID. 1237 South Garvin Pl., Louisville, Ky	Oct. 7, 1908
GREEN, ANDREW H. Canefield, Dominica	Oct. 2, 1901
GREEN, CHARLES NEWTON. Asst. Engr., Public Service Comm., First Dist., 23 Flatbush Ave., Brooklyn, N. Y	June 3, 1903

	Date of Membership
Green, Fred May. Office Engr., P. T. & T. R. R., East River Div., Pennsylvania Station, 32d St. and 7th Ave., New York City	April 6, 1904
Green, James Arleigh. Engr. and Contr., 220 La Salle St., Chicago, Ill.	Jan. 8, 1908
Green, James Cowan. 858 Myrtle Ave., Albany, N. Y.	April 6, 1909
Green, Paul Evans. Cons. Civ. and San. Engr., 125 La Salle St., Chicago, Ill.	July 10, 1907
Green, Theodore. Care, Ferro Concrete Constr. Co., Richmond and Harriet Sts., Cincinnati, Ohio	Mar. 1, 1910
Greenalch, Wallace. Commr. of Public Works, Albany, N. Y. (*Jun., April 3, 1894*)	June 7, 1899
Greene, Albert Emerson. Junior Prof. of Civ. Eng., Univ. of Michigan, 415 East William St., Ann Arbor, Mich.	May 4, 1904
Greene, Carleton. (Greene & Greene, Cons. Engrs.), 11 Broadway, New York City	Mar. 3, 1897
Greene, Frederick Stuart. Vice-Pres. and Gen. Mgr., The Waterproofing Co., 150 East 36th St., New York City	June 7, 1899
Greene, Howard Arnold. Div. Erecting Mgr., Am. Bridge Co. of N. Y., 1525 Frick Bldg., Pittsburg, Pa.	June 5, 1895
Greene, William Stewart. Engr., Constr. Dept., Long Island R. R., Colonial Hall, Jamaica, N. Y.	May 4, 1909
Greenman, Russell Soule. Res. Engr., Testing Laboratory, State Engr.'s Dept., State Hall, Albany, N. Y.	Aug. 31, 1909
Greensfelder, Albert Preston. Secy., Fruin-Colnon Contr. Co., 506 Merchants Laclede Bldg., St. Louis, Mo. (*Jun., May 3, 1904*)	May 2, 1906
Greenwood, Albert Henry. Structural Engr. and Mill Archt., 847 Main St., Hartford, Conn.	Feb. 1, 1905
Gregory, Alfred Cookman. Engr. of Sewers (Res., 555 Rutherford Ave.), Trenton, N. J.	June 5, 1907
Gregory, Charles Emerson. Mt. Kisco, N. Y. (*Jun., Oct. 6, 1896*)	Mar. 6, 1901
Griffin, Arthur James. Engr. of Constr., Bureau of Sewers, 215 Montague St., Brooklyn, N. Y.	Dec. 7, 1904
Griffin, John Alexander. Asst. Engr., Southern R. R., 300 Eleventh St., Lynchburg, Va.	Jan. 3, 1911
Griffith, John Howell. Asst. Prof., Civ. Eng., Univ. of Michigan, 928 Oakland Ave., Ann Arbor, Mich.	April 3, 1907
Griffith, Lawrence. Cons. Engr., Yonkers, N. Y.	May 2, 1900
Grimm, Henry England. P. O. Box 640, Chicago, Ill. (*Jun., Oct. 2, 1900*)	Nov. 4, 1908
Griswold, Harry Todd. Old Lyme, Conn. (*Jun., Oct. 6, 1903*)	Dec. 4, 1907
Griswold, Lee Swaney. Junior Engr., U. S. Engr. Office, 665 Monadnock Bldg., San Francisco, Cal.	Dec. 6, 1910
Griswold, Ray Elliott. Pres., Elk Creek Lumber Co., Cottage Grove, Ore.	Oct. 1, 1902
Groat, Benjamin Feland. Hydr. Engr., Massena, N. Y.	May 3, 1910
Gronwall, Thomas Hagen. Address unknown. (*Jun., Jan. 3, 1907*)	April 6, 1909
Gross, Charles Frederick. Engr. for Wm. Steele & Sons Co., 1600 Arch St., Philadelphia, Pa.	Sept. 2, 1908
Gross, Daniel Wingerd. Engr. of Constr., Atlantic Coast Line R. R. Co., Wilmington, N. C.	May 1, 1901
Grover, Nathan Clifford. Irrig. Engr., J. G. White & Co., Inc., 43 Exchange Pl., New York City	Mar. 2, 1904
Grover, Oscar Llewellyn. Bridge Engr., C. & O. Ry., 8th and Main Sts., Richmond, Va.	Mar. 2, 1909
Gubelman, Frederick Joseph. Pres., The Regina Co., Eastern Constr. Co.; Secy.-Treas., Gubelman Pub. Co., 1 Madison Ave., New York City.	Oct. 2, 1895
Gude, Albert Valdemar, Jr. 712 Grant Bldg., Atlanta, Ga.	June 5, 1907
Gudewill, Charles Edward. Vice-Pres., Montreal Pipe Foundry Co., P. O. Box 2304, Montreal, Que., Canada	Sept. 1, 1897
Gudmundsson, Gisli. Empire Bldg., Pittsburg, Pa.	Jan. 3, 1900
Gueringer, Louis Amedee. Chf. Engr., Port O'Connor, Rio Grande & Northern Ry., Victoria, Tex.	May 7, 1902
Guise, Philip. Asst. Engr., Dept. of Docks and Ferries, Gowanus Section Office, Ft. of 32d St., Brooklyn, N. Y.	Nov. 6, 1907
Gundersen, August. Care Hoyer Ellefsen, Toldbodgaden 30, Christiania, Norway	Oct. 2, 1907
Gustafson, Gustaf Edward. Bldg. Constr. Engr., Board of Education, 3748 Maple Sq. Ave., Chicago, Ill.	July 10, 1907
Gustin, R Prosper. 285 Rich Ave., Mt. Vernon, N. Y.	May 1, 1907
Guthrie, Keith Osmond. Eng. Contr., Waterford, N. Y.	May 3, 1905

Haas, Philip Lippman. Asst. Engr., New York State Highway Comm. (Res., 21 Hammersley Ave.), Poughkeepsie, N. Y.	May 6, 1908
Hadsall, Joseph Canby. Civ. and Hydr. Engr., Wheatland, Wyo.	Nov. 8, 1909
Hadwen, Theodore Lovel Donner. Engr. of Masonry Constr., C., M. & St. P. Ry., 1359 Railway Exchange, Chicago, Ill.	Oct. 7, 1908
Haehl, Harry Lewis. With Duryea, Haehl & Gilman, 1314 Humboldt Bank Bldg., San Francisco, Cal. (*Jun., Oct. 6, 1903*)	July 9, 1906

	Date of Membership
Hagar, Edward McKim. Pres., Universal Portland Cement Co., 1434 Commercial Bank Bldg., Chicago, Ill.	Feb. 6, 1901
Hager, Albert Bertram. Secy., Fidelity Eng. & Inspecting Co., 30 Church St., New York City	Nov. 1, 1905
Haggart, Cecil Neil. 79 N. Allen St., Albany, N. Y.	May 6, 1908
Hague, William. 22 William St., New York City	Oct. 4, 1910
Hain, James C. Constr. Engr., 1735 Mission St., South Pasadena, Cal.	May 1, 1901
Haldeman, Walter Stanley. 510 Hall Bldg., Kansas City, Mo.	Oct. 5, 1909
Hale, Richard King. Cons. Engr. (Richardson & Hale), 85 Water St., Boston, Mass. (*Jun., April 4, 1905*)	Feb. 1, 1910
Hall, Charles Romney. 1005 Hooker & Lent Bldg., San Francisco, Cal.	Jan. 7, 1903
Hall, Hubert Harry. Prin. Asst. Engr. with Standard Oil Co. of California, 461 Market St., San Francisco, Cal. (*Jun., April 30, 1907*)	May 3, 1910
Hall, Louis Wells. Engr., U. S. Reclamation Service, Fallon, Nev.	Oct. 1, 1902
Hall, Martin Welch. Asst. Engr., Bureau of Sewers, Borough of the Bronx, New York City. (*Jun., Oct. 1, 1901*)	Nov. 7, 1906
Hall, Robert Elliot. (Aldrich & Hall), Auburn, N. Y. (*Jun., Sept. 6, 1904*)	June 30, 1910
Hall, Warren Esterly. Div. Engr., Porto Rico Irrig. Service, Juana Diaz, Porto Rico. (*Jun., Nov. 5, 1907*)	June 30, 1910
Hall, William Henry. (Hall & Bacon), 272 Main St., New Britain, Conn.	Oct. 4, 1910
Halsey, Edmund Ryond. 164 Market St., Newark, N. J.	Feb. 7, 1906
Hamill, Alexander Sylvester. 426 Montgomery St., Jersey City, N. J. (*Jun., Dec. 28, 1900*)	April 6, 1909
Hamill, William Samuel. Care, Hudson Valley Constr. Co., Comstock, N. Y.	Mar. 1, 1910
Hamilton, Farrar Petrie. 662 North State St., Jackson, Miss.	June 3, 1908
Hamlin, Ralph. Asst. Engr., Corrugated Bar Co., 710 Pioneer Press Bldg., St. Paul, Minn. (*Jun., Jan. 5, 1904*)	Oct. 5, 1909
Hanavan, William Lawrence. Asst. Engr., Board of Water Supply of New York City, R. F. D. No. 4, Newburgh, N. Y. (*Jun., Dec. 6, 1904*)	Dec. 6, 1910
Hancock, Henry Sydney, Jr. City and Water-Works Engr., Fort William, Ont., Canada. (*Jun., Oct. 6, 1903*)	April 5, 1910
Hancock, Lewis Wernette. Pres., The L. W. Hancock Co., Engrs. and Contrs., 1412 Lincoln Bank Bldg., Louisville, Ky.	Jan. 2, 1907
Haney, Lewis Tustler. 1 Crooke Ave., Brooklyn, N.Y. (*Jun., Oct. 7, 1902*).	Mar. 1, 1905
Hanley, William Scott. 252 West 65th St., Chicago, Ill.	Nov. 1, 1910
Hanna, Walter Scott. Cons. Engr. with J. B. Hogg, Lykens, Pa. (*Jun., Oct. 6, 1903*)	June 5, 1907
Hansell, William Albert. Civ. Engr. and Supt. of Constr., 630 Highland Ave., Atlanta, Ga.	Oct. 5, 1909
Hansen, Paul. State San. Engr. of Kentucky, Bowling Green, Ky. (*Jun., Jan. 3, 1905*)	April 1, 1908
Harbeck, Henry Russell. Engr. and Supt. of Constr., Leonard Constr. Co., 1937 McCormick Bldg., Chicago, Ill.	June 3, 1908
C. Harby, Isaac. Civ. Engr. for John A. Roebling's Sons Co., Trenton, N. J. (*Jun., June 6, 1899*)	May 6, 1903
Hardesty, James Robert. Mgr., Virginia Bridge & Iron Co., 707 Hibernia Bank Bldg., New Orleans, La.	Feb. 2, 1909
Hardin, Abraham Tracy. Asst. Gen. Mgr., N. Y. C. & H. R. R. R. Co., Grand Central Terminal, New York City	Mar. 2, 1904
Harding, Robert John. Supt. of Public Works, Poughkeepsie, N. Y.	Nov. 4, 1908
Harding, William Stewart. Bituminous Coal Operator, Arcade Bldg. (Res., 3411 Hamilton St.), Philadelphia, Pa. (*Jun., Nov. 3, 1896*)	Oct. 3, 1906
Hardison, Allen Crosby. Civ. and Min. Engr., Santa Paula, Cal.	Feb. 6, 1901
Hardman, Roy Cordis. Civ. Engr. and Supt. of Constr., War Dept., Fort Crockett, Galveston, Tex.	Oct. 7, 1908
Hardt, Charles William. Div. Engr., State Highway Dept., Harrisburg, Pa.	July 1, 1909
Harley, George Foster. Res. Engr., J. G. White & Co., Jackson, Ga.	Jan. 3, 1911
Harlow, James Hayward, Jr. Asst. Engr., Susquehanna Power Co., Darlington, Harford Co., Md.	Mar. 5, 1902
Harman, Jacob Anthony. Agricultural and San. Drainage, 120 Fredonia Ave., Peoria, Ill.	May 4, 1898
Harper, Isaac Onward. Secy. and Treas., Lauer & Harper Co., Baltimore, Md.	May 7, 1902
Harper, Sinclair Ollason. Asst. Engr., U. S. Reclamation Service, Grand Junction, Colo. (*Jun., Mar. 31, 1908*)	Jan. 3, 1911
Harps, Harry Macy. Res. Engr., Celilo Bridge, Celilo, Ore. (*Jun., Mar. 3, 1903*)	Oct. 2, 1907
Harrington, Allan Collins. Cons. Engr., 518 N. Illinois St., Indianapolis, Ind.	Oct. 2, 1907
Harrington, Francis Burchard. Trainmaster, N. Y. C. & H. R. R. R., Union Station, Albany, N. Y. (*Jun., Sept. 11, 1900*)	Feb. 5, 1908
Harrington, Harry Garfield. Eng. Dept., The New Jersey Zinc Co., 71 Broadway, New York City. (*Jun., Jan. 7, 1902*)	Feb. 7, 1906

	Date of Membership
Harris, Archie Lee. Asst. Engr., U. S. Reclamation Service, 421 Fleming Bldg., Phœnix, Ariz.	May 31, 1910
Harris, Borden Baker. Asst. Chf. Engr., J. G. White & Co., Inc., Philippine Ry. Constr., Iloilo, Philippine Islands	April 3, 1907
Harris, George Henry. Div. Engr., Mich. Cent. R. R., St. Thomas, Ont., Canada	May 3, 1910
Harris, Guy Walter. Chf. Engr. of Constr., The Pecos & Northern Texas Ry. Co., Amarillo, Tex	June 5, 1907
Harris, Henry Alexander. 176 Nassau St., Princeton, N. J. *(Jun., Oct. 31, 1899)*	June 7, 1905
Harris, Jay Butler. Reinforced Concrete Engr., 521 Citizens National Bank Bldg., Los Angeles, Cal	Oct. 2, 1907
Harshbarger, Elmer Dwight. Engr., Pitt Constr. Co., 821 Fulton Bldg., Pittsburg, Pa. *(Jun., Nov. 5, 1901)*	Jan. 3, 1906
Hart, Reuben Charles. Howes Blk., Clinton, Iowa	Sept. 2, 1908
Harting, Otto Frederick. Prin. Asst. Engr., Terminal R. R. Assoc. of St. Louis (Res., 3817 Russell Ave.), St. Louis, Mo	April 5, 1910
Hartman, Alfred Hanson. Div. Engr., Storm Water and Low Level Divisions, Sewerage Comm., City of Baltimore, 908 American Bldg., Baltimore, Md. *(Jun., Dec. 6, 1904)*	Dec. 5, 1906
Hartman, August Frederick. Chf. Draftsman, Geo. F. Hardy, 309 Broadway, New York City	Dec. 4, 1907
Hartung, Paul August. Civ. and Irrig. Engr., Greeley, Colo	Sept. 6, 1910
Harvey, Clarke Kennerley. Asst. to Harry J. Lewis, Engr., 602 Times Bldg., Pittsburg, Pa	May 3, 1910
Hasbrouck, Oscar. Engr. for Holler & Shepard, 24 Fairview Ave., Northside, Cohoes, N. Y. *(Jun., Jan. 3, 1907)*	Nov. 8, 1909
Haselwood, Fred Willis. Civ. and Hydr. Engr., 675 Monadnock Bldg., San Francisco, Cal. *(Jun., Jan. 3, 1907)*	Sept. 6, 1910
Haskell, Frank Hampton. Div. Engr., C. & O. Ry., Covington, Ky	Jan. 8, 1908
Hastings, Edgar Morton. Res. Engr., R., F. & P. R. R., Richmond, Va	June 30, 1910
Hatt, William Kendrick. Prof. of Civ. Eng., Purdue Univ.; Civ. Engr., Forest Service, U. S. Dept. of Agri., Lafayette, Ind	June 4, 1902
Hattan, William Cary. Div. Engr., Carter Constr. Co., Meyersdale, Pa	Nov. 6, 1907
Hatton, Herbert Watson. Cons. Engr., Y. M. C. A. Bldg., Wilmington, Del. *(Jun., April 4, 1905)*	June 1, 1909
Hauck, William. Asst. Engr., Aqueduct Comm., New York City, Brewster, N. Y	June 5, 1901
Havens, Ralph DeWitt. 451 West Ave., Pawtucket, R. I	Aug. 31, 1909
Havens, Verne LeRoy. Chf. Engr., Elec. Tramways, 4ª Puente de Alvarado 92, City of Mexico, D. F., Mexico. *(Jun., Oct. 3, 1905)*	April 1, 1908
Hawkesworth, John. 100 West 80th St., New York City. *(Jun., Sept. 6, 1904)*	Nov. 4, 1908
Hawkins, Irving. 61 Wall St., Kingston, N. Y	May 6, 1908
Hawley, Charles Ray. Princeton, W. Va. *(Jun., Feb. 5, 1907)*	April 5, 1910
Hawley, George Prince. Cons. Engr., De Pere, Wis	Feb. 6, 1901
Hawn, Russell John. Supt., Virginia Portland Cement Co., Fordwick, Va.	Nov. 30, 1909
Hayden, Edwin Clapp. 16 City Sq., Room 4, Charlestown, Mass. *(Jun., Oct. 1, 1901)*	June 7, 1905
Hayes, Andrew Jenkins. Care, U. S. Reclamation Service, Fort Shaw, Mont	Sept. 6, 1910
Hayes, Charles Edward. Asst. Engr., U. S., Reclamation Service, Helena, Mont. *(Jun., Mar. 6, 1906)*	May 31, 1910
Hayes, Morgan Dodge. 565 West 113th St., New York City	April 1, 1903
Hayes, Ralph Daniel. Stillwater, N. Y. *(Jun., June 4, 1907)*	Aug. 31, 1909
Haylow, James Henry. Chf. Engr., The Memphis St. Ry. Co., Memphis, Tenn	Dec. 5, 1906
Haynes, Claude Sanford. Asst. Engr., Bureau of Sewers, 215 Montague St., Room 916, Brooklyn, N. Y	Jan. 4, 1910
Haynes, George Albert. Engr. and Gen. Mgr., Stone City Steel Constr. Co., Bedford, Ind	Sept. 2, 1908
Hays, David Walker. Reno, Nev	May 31, 1910
Hays, Don. Dist. Engr., C., M. & P. S. R. R., 258 Front Ave., Spokane, Wash	May 6, 1903
Hays, Donald Symington. Locating Engr. with MacKenzie, Mann & Co., Victoria, B. C., Canada	Oct. 4, 1910
Hazard, Erskine. Min. Engr. for The Virginia Coal & Iron Co., Big Stone Gap, Va	Oct. 2, 1895
Hazard, William Abbott. Mgr., Lackawanna Bridge Co., P. O. Box 97, Buffalo, N. Y	Nov. 8, 1909
Hazelton, William Sylvester. Mgr., Chicago Office, Corrugated Bar Co., 1825 Commercial National Bank Bldg., Chicago, Ill	May 4, 1909
Hazlett, Robert. City Bank Bldg., Wheeling, W. Va	Mar. 4, 1896
Heald, Edward Creswell. Chf. Structural Engr., Office of Superv. Archt., Treasury Dept., Washington, D. C. *(Jun., Oct. 7, 1902)*	May 2, 1906
Healey, Charles Frank. 613 Bankers Trust Bldg., Tacoma, Wash	June 30, 1910

	Date of Membership
Healy, John Paul. Prin. Asst. Insp. of Bldgs., Dist. of Columbia, Washington, D. C.	Dec. 6, 1910
Hebard, Roy William. (Hebard & Alberts), Bohio, Canal Zone, Panama.	Feb. 6, 1907
Heck, Nicholas Hunter. Asst., U. S. Coast and Geodetic Survey, Washington, D. C.	July 1, 1909
Heer, William, Jr. U. S. Junior Engr., Pennington, Ala. (*Jun., Nov. 5, 1907*)	April 6, 1909
Heiges, Thomas Tyrrell. 47 E. Market St., York, Pa.	Feb. 5, 1908
Heindle, William Albert. Mgr. of Rys., Wilmington & Philadelphia Traction Co., and Southern Pennsylvania Traction Co., Wilmington, Del.	Nov. 6, 1901
Heller, John Walter. Eng. Contr., 738 Broad St., Newark, N. J.	June 6, 1906
Henderson, Adelbert Andrew. County Engr.'s Office, Room 308, Court House, Pittsburg, Pa.	April 4, 1906
Henderson, Samuel Whilden. Mgr., The Excelsior Springs Light, Power, Heat & Water Co.; Mgr., The Marysville Light, Power & Water Co., Excelsior Springs, Mo.	Sept. 6, 1905
Hendricks, Kearney Everett. Instr. in Civ. Eng., Lehigh Univ., South Bethlehem, Pa.	Oct. 4, 1910
Hendricks, Victor King. Office Engr., Frisco Lines, St. Louis, Mo.	May 1, 1895
Henry, Francis Maxwell. Lumber Exchange, Minneapolis, Minn.	Mar. 4, 1896
Hermanns, Frank Edward. Care, Ed. F. Hermanns, 24 Butter's Court, Denver, Colo.	Jan. 3, 1906
Herrick, John James. Dept. of Docks and Ferries, Foot, West 56th St., New York City.	June 6, 1900
Herring, Jerome Campbell. Cons. Engr., 2201 Jackson Ave., Kansas City, Mo.	April 5, 1905
Hersey, Guy Alfred. Civ. Engr. and Surv., Bass Blk., Room 19, Bangor, Me. (*Jun., June 4, 1907*)	Oct. 7, 1908
Hewat, Henry John. 277 Hamilton Ave., Paterson, N. J.	April 3, 1907
Hewitt, George. Care, Lee & Hewitt, 1123 Broadway, New York City.	Oct. 3, 1906
Hidinger, Leroy Lemayne. 612 Goodwyn Inst. Bldg., Memphis, Tenn.	Oct. 4, 1910
Higgins, Charles Houchin. Cons. Engr., Commercial Trust Bldg., Jersey City, N. J. (*Jun., Jan 2, 1906*)	April 1, 1908
Higgins, Herman Keene. Cons. Engr., 1105 Exchange Bldg., Boston, Mass.	Nov. 7, 1906
Higgins, James Wallace. Civ. and Landscape Engr., 347 Fifth Ave., New York City (Res., Roselle Park, N. J.)	April 3, 1907
Higginson, Jonathan Yates. Asst. Engr., N. Y., N. H. & H. R. R. Co., Harlem River Station, New York City (Res., 88 Centre Ave., New Rochelle, N. Y.) (*Jun., Oct. 1, 1901*)	Nov. 8, 1909
Highley, Lee. Chf. Engr., Pacific & Idaho Northern R. R., Weiser, Idaho. (*Jun., Dec. 7, 1897*)	Dec. 4, 1901
Hildreth, John Lewis, Jr. Asst. Engr. in Chg., Sec. 4, Moodna Siphon, Board of Water Supply, Vail Gate, N. Y.	Dec. 6, 1905
Hill, Edwin Allston. Asst. Examiner, Patent Office, 1221 K St., N. W., Washington, D. C.	May 3, 1893
Hill, George Samuel. 1305 Call Bldg., San Francisco, Cal. (*Jun., Jan. 3, 1907*)	June 1, 1909
Hill, John J. Engr. for James Stewart & Co., New York State Barge Canal Contracts Nos. 12 and 39, 73 Downer St., Baldwinsville, N. Y.	April 5, 1910
Hill, Theodore William. Contr. Engr., Bellefontaine, Ohio.	Mar. 7, 1900
Hill, Walter Arthur. Chf. Engr. and Supt., Vera Cruz & Pacific R. R., Calle Real de Churubusco No. 13, Churubusco, D. F., Mexico.	Sept. 2, 1896
Hiller, John Augustus. Supt. of Distrib., City Water Dept., City Hall, Cincinnati, Ohio.	Sept. 7, 1904
Hillman, George Waldo. Asst. Engr., Tex. & Pac. Ry. Co., Boyce, La.	April 1, 1908
Hilton, Harry LeGrand. U. S. Navy Yard, P. O. Box 472, Portsmouth, N. H.	June 1, 1909
Hilton, Joseph Churchill. Secy., Mason, Hilton & Co., Contrs., 111 Broadway, New York City.	Jan. 2, 1907
Hilts, Harold Ezra. 129 Coligni Ave., New Rochelle, N. Y.	May 31, 1910
Hirst, Arthur. Engr., Trenton Plant, Am. Bridge Co., Trenton, N. J.	Dec. 3, 1902
Hoad, William Christian. Associate Prof. of Civ. Eng., Univ. of Kansas, Lawrence, Kans.	Dec. 5, 1906
Hodgdon, Benjamin Alexander. Asst. Engr., Public Service Comm. for First Dist., State of New York, 154 Nassau St., New York City.	Mar. 2, 1909
Hodgdon, John Brewster. City Engr.; Asst. Engr., Mo., Kans. & Tex. Ry. Co., 2101 Wall St., Joplin, Mo.	April 3, 1907
Hoffman, William Otto. Care, H. C. Stowe Constr. Co., 221 Greenpoint Ave., Brooklyn, N. Y.	Jan. 8, 1908
Hogue, Charles Jay. 5720 Walnut St., Philadelphia, Pa.	Dec. 7, 1898
Hogue, Chester James. Const. Engr., The Concrete Eng. Co., Paddock Bldg., Boston, Mass.	Dec. 6, 1905
Holbrook, Percy. Vice-Pres., The Rail Joint Co., 185 Madison Ave., New York City.	Mar. 2, 1898
Holbrook, Winfield. Chf. Engr., Beaver Land & Irrig. Co., Penrose, Colo. (*Jun., Mar. 3, 1908*)	Oct. 4, 1910

	Date of Membership
Holden, Charles Arthur. Prof. of Civ. Eng., Thayer School of Civ. Eng., Dartmouth Coll., Hanover, N. H. (*Assoc. Nov. 1, 1905*)	Mar. 1, 1910
Holdrege, Henry Atkinson. Gen. Mgr., Omaha Elec. Light & Power Co., Omaha, Nebr.	Dec. 7, 1904
Holley, Carl Hiram. Cons. and Superv. Engr.; Mgr., Tulare County Power Co., Porterville, Cal.	June 5, 1907
Holley, Harry Hall. Visalia, Cal.	Oct. 5, 1909
Holliday, Alexander Rieman. Secy., The National Concrete Co., 805 Traction Terminal Bldg., Indianapolis, Ind. (*Jun., Oct. 7, 1902*)	Feb. 1, 1905
Holmes, Edwin Merritt. Gen. Supt., The Juragua Iron Co., Firmeza, Santiago de Cuba, Cuba. (*Jun., Mar. 31, 1903*)	Jan. 2, 1907
Holmes, Frank. Asst. Engr., Thompson-Starrett Co., 51 Wall St., New York City	Dec. 1, 1908
Holt, Lester Morton. Irrig. Engr., U. S. Indian Service at Large, 3551 Thirteenth St., N. W., Washington, D. C.	Oct. 3, 1906
Holtsmark, Erling. Public Service Comm., 154 Nassau St., New York City	April 1, 1908
Homan, William MacLean. Cons. Engr. and Govt. Land Surv., Bethlehem, Orange River Colony, South Africa	June 7, 1899
Honness, George Gill. Div. Engr., Board of Water Supply, Pleasantville, Westchester Co., N. Y. (*Jun., Feb. 2, 1897*)	Sept. 4, 1901
Hood, Hugh Kendall. Res. Engr. for B. H. Hardaway, Smith's Station, Ala.	Feb. 1, 1910
Hood, James Henry. Supt. of Constr., Stone & Webster Eng. Corporation, Hauserlake, Helena, Mont.	April 5, 1910
Hood, Joseph Nelson. Engr., Pittsburg Contr. Co., 236 Grand St., Newburgh, N. Y.	April 3, 1907
Hopkins, Albert Lloyd. Asst. Gen. Mgr., Newport News Shipbuilding & Dry Dock Co., Newport News, Va. (*Jun., April 3, 1894*)	April 3, 1901
Horne, Harold Wellington. Asst. Engr., Board of Water Supply, City of New York, Cornwall-on-Hudson, N. Y.	Oct. 2, 1907
Horstman, Joseph Prosper. Engr. and Gen. Supt., Parkersburg, Marietta & Inter-Urban Ry. Co., Parkersburg, W. Va.	Dec. 7, 1904
Hortenstine, Henry Roberts. Agt., Penn Bridge Co., Key West, Fla.	April 3, 1907
Horton, Albert Howard. Dist. Engr., U. S. Geological Survey, Federal Bldg., Newport, Ky. (*Jun., June 3, 1902*)	Mar. 6, 1907
Horton, Dwight Fred. Gen. Contr. (Horton & Son), Carter Bldg., Houston, Tex. (*Jun., June 6, 1905*)	Feb. 5, 1908
Hosmer, Guy Frederic. With O. Perry Sarle, 146 Westminster St., Providence, R. I.	Nov. 6, 1907
Hough, Frederick Milton. Contr. Engr., Room 29, Vivier Bldg., Brownsville, Tex.	Nov. 6, 1907
Hovey, Ray Palmer. With Utah Copper Co., 600 McCormick Bldg., Salt Lake City, Utah. (*Jun., Jan. 2, 1906*)	Nov. 8, 1909
Howalt, Wilhelm Jens Christian. 590 West 174th St., New York City	June 5, 1907
Howard, Conway Robinson. Engr., Great Southern Lumber Co. and New Orleans, Great Northern R. R., P. O. Box 622, Bogalusa, La.	Dec. 5, 1906
Howard, Ernest Emmanuel. Associate Engr., Waddell & Harrington, 10th Floor, Orear-Leslie Bldg., Kansas City, Mo. (*Jun., Dec. 3, 1901*)	Sept. 6, 1905
Howard, Lewis Thomas. Asst. Engr., New York Barge Canal, Schuylerville, N. Y.	June 3, 1908
Howe, Charles Edward. With Hastings Pavement Co., Hastings-on-Hudson, N. Y. (*Jun., Mar. 6, 1900*)	May 3, 1905
Howe, Clarence Durand. Project Engr., U. S. Reclamation Service, Huntley, Mont.	Feb. 1, 1910
Howe, Harry Northrop. Engr. and Contr. (Gardner & Howe), 51 Porter Bldg., Memphis, Tenn. (*Jun., Dec. 6, 1904*)	April 5, 1910
Howe, Herbert Frank. 9 Miller Ave., North Cambridge, Mass.	Oct. 2, 1907
Howe, Walter Clark. Commr. of Streets, City Hall, Oakland, Cal.	May 31, 1910
Howell, Frank Scott. Civ. Engr. in Chg., U. S. Immigrant Station, Ellis Island, New York Harbor, N. Y. (Res., New York Athletic Club, Central Park South, New York City)	April 4, 1906
Howell, Robert Parsons. Town Surv. and Civ. Engr., 41 Brainard St., Phillipsburg, N. J.	Oct. 4, 1905
Howell, William Augustus. Engr., Streets and Highways, City Hall, Newark, N. J.	April 3, 1907
Hoyt, Henry Perez. Care, Great Northern Paper Co., Millinocket, Me. (*Jun., Oct. 6, 1903*)	Dec. 4, 1907
Hoyt, John T Noye. Care, Albert Kahn, 58 Lafayette Boulevard, Detroit, Mich. (*Jun., Feb. 28, 1893*)	Mar. 2, 1898
Hubbard, Winfred Dean. Asst. Engr., Board of Water Supply, City of New York, West Shokan, N. Y.	Nov. 5, 1902
Hubbell, George Scott. 319 Lincoln St., Flushing, N. Y.	June 1, 1904
Huber, Walter Leroy. Dist. Engr., Dist. 5, U. S. Forest Service, First National Bank Bldg., San Francisco, Cal. (*Jun., April 3, 1906*)	Mar. 1, 1910
Hudson, Darwin Shaw. Asst. Supt. of Constr., The Astoria Light, Heat & Power Co., 157 Franklin St., Astoria, N. Y.	April 5, 1910

	Date of Membership
Hudson, Harold Walton. Asst. Engr., P. T. & T. R. R., Box 348, Woodside, N. Y.	May 3, 1905
Huestis, Charles Calvin. Effingham, Ill.	Mar. 6, 1901
Huff, Clyde Leslie. (Fessenden & Huff), Rupert, Idaho	July 1, 1909
Hufschmidt, William Paul. 725 Newport St., Denver, Colo	Oct. 4, 1910
Hughes, Francis Dey. Contr. Engr., Illinois Steel Bridge Co., Room 6, Central Bldg., Kansas City, Mo	Sept. 3, 1902
Hulse, Shirley Clark. Field Engr., Second Clackamas Development, Cazadero, Ore. *(Jun., Oct. 7, 1902)*	Feb. 6, 1907
Hunicke, William August. Constr. Engr., Cuban Central Rys., Sagua La Grande, Cuba	Mar. 2, 1904
Hunt, Charles Adams. Asst. Div. Engr., Public Service Comm., 154 Nassau St., New York City	Oct. 4, 1905
Hunt, Leigh Anson. Pres. and Gen. Mgr., Hunt Eng. Co., Iola, Kans.	Feb. 6, 1907
Hunt, Loren Edward. Asst. Engr., Dept. of Public Works, 38 Sixth Ave., San Francisco, Cal	June 3, 1903
Hunter, Adam. Chf. Engr. to *Sir* Wm. Arrol & Co., Ltd., 85 Preston St., Bridgeton, Glasgow, Scotland	Sept. 6, 1905
Hunter, John. Care, Brown-Hunter Co., 407 Dollar Bank Bldg., Youngstown, Ohio	Feb. 6, 1907
Hunter, Robert Easton. 2320 Mance St., Montreal, Que., Canada	Nov. 6, 1901
Hunter, Thomas Benton. Res. Engr., Monterey County Water-Works, Monterey, Cal. *(Jun., April 4, 1905)*	July 1, 1909
Hunting, Eugene Nathan. Reinforced Concrete Engr. for Nicola Bldg. Co., 2115 Farmers Bank Bldg., Pittsburg, Pa. *(Jun., Nov. 1, 1904)*	April 1, 1908
Huntington, George Danforth. Pres., Raquette Foundry & Supply Co., Massena, N. Y.	Dec. 7, 1904
Huntington, Linn Murdoch. Locating Engr., Direccion General de Obras Publicas, Santo Domingo, Santo Domingo. *(Jun., May 2, 1905)*	Aug. 31, 1909
Hurlbut, Charles Chase. Engr. with Kenneth M. Murchison, Archt., 298 Fifth Ave., New York City	Dec. 5, 1906
Hurlbut, Hinman Barrett. Engr. Expert Aid, Bureau of Yards and Docks, Navy Dept., 1822 U St., N. W., Washington, D. C.	July 1, 1909
Huston, Tillinghast L'Hommedieu. Gen. Contr., Zulueta 46, Havana, Cuba	May 2, 1900
Hutchins, Edward. East Walpole, Mass. *(Jun., June 6, 1905)*	Jan. 4, 1910
Hyatt, Caleb. Care, Harlem Contr. Co., 201st St. and 9th Ave., New York City. *(Jun., Mar. 3, 1903)*	April 5, 1905
Hyde, Howard Elmer. Engr. in Chg., Design, Havana Sewerage and Drainage Systems, O. P. Arsenal, Havana, Cuba	April 4, 1906
Hyde, John Lawrence. Asst. Town Engr., Westfield, Mass	July 10, 1907
Hyde, William Herbert. Contr., 170 Lincoln Ave., Bellevue, Pa. *(Jun., April 30, 1901)*	June 4, 1902

Ichinose, Kyojiro. Dobokukyoku, Naimusho, Tokyo, Japan	Jan. 8, 1908
Ijams, Jesse Warren. Mech. Engr., Gen. Purchasing Dept., N. Y. C. Lines, 1420 Grand Central Terminal, New York City	April 6, 1909
Ilsley, Arthur Benjamin. Bridge Engr., Southern Ry., 1300 Penn. Ave., Washington, D. C. *(Jun., Feb. 28, 1899)*	Mar. 4, 1903
Immediato, Gerardo. Town Engr., Montclair, N. J	July 9, 1906
Inagaki, Hyotaro. Res. Engr., Imperial Govt. Ry., Ikegamimura, Ebaragori, Tokyo, Japan	Oct. 2, 1907
Ingersoll, Charles Anthony. Res. Engr., N. Y. State Barge Canal, Medina, N. Y.	Nov. 7, 1906
Ingram, Edward Lovering. Asst. Prof. of R. R. Eng. and Geodesy, Univ. of Pennsylvania (Res., 3643 Locust St.), Philadelphia, Pa	Sept. 4, 1895
Ingram, Willard Edward. Chf. Structural Engr., The Arnold Co., 181 La Salle St., Chicago, Ill.	Oct. 2, 1907
Innes, Harry Clifford. Cons. and Const. Engr., Station R, Cincinnati, Ohio	Feb. 6, 1907
Insley, William Henry. Pres., Insley Mfg. Co., Indianapolis, Ind	Aug. 31, 1909
Irish, Leland Wesley. Asst. Engr., Dept. of Highways, Albany, N. Y. *(Jun., Feb. 4, 1908)*	Feb. 1, 1910
Ives, Howard Chapin. Asst. Prof. of R. R. Eng., Worcester Polytechnic Inst., Worcester, Mass. *(Jun., Dec. 3, 1901)*	April 5, 1910

Jackson, Granbery. Engr., International Agri. Corporation, 1109 Stahlman Bldg., Nashville, Tenn	Jan. 4, 1905
Jackson, John Franklin. Contr. Engr., Wisconsin Bridge & Iron Co., 605 Colby-Abbot Bldg., Milwaukee, Wis	May 2, 1894
Jacobs, Robert Hyde. Senior Asst. Div. Engr., Public Service Comm., First Dist., 14 Morningside Ave., New York City	May 4, 1904
Jacobson, Alfred Leon. Chf. Engr., Coignet & Co., 28 Villa Dupont, Paris, France	April 5, 1910

ASSOCIATE MEMBERS J-K

	Date of Membership
JAHNCKE, ERNEST LEE. Vice-Pres. and Gen. Mgr., The Jahncke Nav. Co., New Orleans, La.	July 10, 1907
JAMES, ALFRED RANDOLPH. Junior Engr., Miraflores Locks, Corozal, Canal Zone, Panama	Nov. 8, 1909
JAMES, MERTON EARLE. Barge Canal Office, Amsterdam, N. Y.	Oct. 4, 1910
JANNEY, THOMAS GORDON. Gen. Mgr., The Shasta Dredging Co., Larkin, Cal.	Oct. 3, 1900
JANSEN, EDWARD CLINTON. Care, Central Colorado Power Co., 1210 Seventeenth St., Denver, Colo.	Nov. 3, 1905
JANVRIN, NED HERBERT. 18 Lutheran St., Newburgh, N. Y. (*Jun., Oct. 5, 1897*)	June 5, 1901
JAQUES, JACOB DUNCAN. 116 Euclid St., Woodbury, N. J.	Nov. 1, 1910
JENKINS, JAMES EDGAR. Engr. for Thomas Crimmins Contr. Co. (Res., 3440 Broadway), New York City	Dec. 5, 1906
JENNINGS, JOHN EDWARD. 1469 Pacific St., Brooklyn, N. Y.	Nov. 30, 1909
JEWETT, JOHN YOUNG. Cement Expert, U. S. Reclamation Service, 408 Commonwealth Bldg., Denver, Colo.	Sept. 6, 1910
JEWETT, THOMAS EDWARD. Vice-Pres., H. L. Stevens & Co., Houston, Tex.	Nov. 30, 1909
JOHANNESSON, SIGVALD. 317 Park Ave., Newark, N. J.	Nov. 1, 1905
JOHNSON, ALEXANDER. Cons. Engr., Dept. of Bridges, 13 Park Row, New York City	Sept. 5, 1900
JOHNSON, EDWIN SAMUEL. Mgr., South Penn. Rys. & Light Co., Frostburg, Md.	Oct. 2, 1907
JOHNSON, GEORGE ARTHUR. (Johnson & Fuller, Hydr. and San. Engrs.), 150 Nassau St., New York City	Feb. 6, 1907
JOHNSON, GEORGE RUFUS. 700 Washington Ave., West Haven, Conn.	May 1, 1907
JOHNSON, MARO. Asst. Engr., Ill. Cent. R. R., 6549 Minerva Ave., Chicago, Ill.	April 6, 1909
JOHNSON, NATT MADISON. Supt. of Concrete, Isthmian Canal Comm., Gatun, Canal Zone, Panama	Oct. 4, 1910
JOHNSON, RANKIN. 35 Madison Ave., New York City	Feb. 7, 1900
JOHNSON, ROBERT CHAN. Div. Engr. and Technical Advisor to Pres., Hunan Yueh-Han Ry. Co., Changsha, Hunan Province, China	Feb. 1, 1910
JOHNSON, WILLIAM EDWARD. Engr. in Chg. of Reservoirs, Hartford Water-Works, P. O. Box 382, West Hartford, Conn.	April 3, 1901
JOHNSTON, CHARLES EUGENE. Chf. Engr., Kansas City Southern Ry., Kansas City, Mo.	June 1, 1909
JOHNSTON, JOHN PARRY. Gen. Mgr., The New York Engine Co., 165 Broadway, New York City. (*Assoc. April 3, 1894*)	Nov. 1, 1904
JOHNSTON, JULIUS GERARDUS. Address unknown	Feb. 6, 1907
JOHNSTONE, WILLIAM BARD. Cons. Engr., 1123 Broadway, New York City.	May 4, 1904
JONES, FREDERICK ARMISTEAD. Asst. Engr., Mo. Pac. Ry. Co., M. of W. Dept., Title Guarantee Bldg., St. Louis, Mo.	Nov. 8, 1909
JONES, HENRY LLEWELLYN. Res. Engr., U. S. Steel Products Export Co., 30 Church St., New York City	Oct. 5, 1898
JONES, JONATHAN. Engr., Pottstown Plant, McClintic-Marshall Cons. Co., Pottstown, Pa.	Sept. 6, 1910
JONES, ROBERT SHARP. Chf. Engr., The James Westwater Co., Engrs. and Contrs., 501 Wyandotte Bldg., Columbus, Ohio	June 30, 1910
JONES, SAMUEL REYNOLDS. Structural Engr., J. G. White & Co., 43 Exchange Pl., New York City	April 6, 1909
JONES, SIDNEY GARDNER. Asst. to Chf. Engr., M., St. P. & S. Ste. M. Ry., Soo Line, Gen. Offices (Res., 122 West Grant St.), Minneapolis, Minn.	Jan. 2, 1907
JONES, THOMAS JOHN. 95 Bellevue Ave., San Mateo, Cal.	June 1, 1904
JONES, WALTER ALPHEUS. Asst. Engr., L. V. R. R., Box 30 Weatherly, Pa.	Nov. 30, 1909
JONSON, ERNST FREDRIK. Engr. Insp., Board of Water Supply, 147 Varick St., New York City	Jan. 3, 1900
JORDAHL, ANDERS. Care, Deutsche Kahneisen Gesellschaft, 77 Charlotten Strasse, Berlin, Germany	Nov. 6, 1907
JORDAN, WILLIAM FREDERICK. Mgr., Grand Central Terminal Impvts., 124 Fisher Ave., White Plains, N. Y.	April 1, 1891
JORGENSEN, LARS RASMUS. Designing Engr., F. G. Baum & Co., 1406 Chronicle Bldg., San Francisco, Cal.	May 4, 1909
JOUETT, HENRY DETRICK. Designing Engr., N. Y. C. & H. R. R. R., 335 Madison Ave., New York City	Feb. 7, 1906
JUBB, SHERMAN AUGUSTUS. Cons. Engr., 3151 California St., San Francisco, Cal.	Mar. 6, 1907
JUDD, FRANK RHYMAL. Chf. Draftsman, Bridge Dept., Ill. Cent. R. R., Chicago, Ill.	Mar. 2, 1909
JUDELL, ADOLPH. 20 Front St., San Francisco, Cal.	April 4, 1906
KABASHIMA, MASAYOSHI. Eng. Dept., City Hall, Tokyo, Japan	May 2, 1906
KAFKA, FREDERICK PERCEVAL. Pres., Herringbone Metal Lath Co., 257 East 133d St., New York City (Res., 49 Washington Ave., New Rochelle, N. Y.)	May 1, 1907

	Date of Membership
C. Kahn, Julius. Care, Trussed Concrete Steel Co., Detroit, Mich. (*Jun., May 3, 1898*)	Oct. 3, 1900
Kanary, Mark Henry. Gen. Supt., Des Moines Bridge & Iron Co., 1073 Twenty-eighth St., Des Moines, Iowa	May 3, 1910
Kast, Clarke Nightingale. Dist. Engr., Bureau of Public Works, Manila, Philippine Islands. (*Jun., June 4, 1901*)	June 7, 1905
Kastenhuber, Edwin Gustav, Jr. P. O. Box 677, Bordentown, N. J.	July 1, 1909
Kauffman, Vernet Albert. 1768 Emerson St., Denver, Colo. (*Jun., Feb. 3, 1903*)	July 10, 1907
Kawaguchi, Torao. Koto Kogyogakko (Higher School of Technology), Kumamoto, Japan	Oct. 4, 1905
Kays, Marion Reed. Asst. Chf. Engr., Idaho Irrig. Co., Ltd., Richfield, Idaho	Dec. 6, 1910
Keator, Edward Orris. Civ. Engr. and Contr., Cincinnati, Ohio	May 31, 1910
Keays, Reginald Horton. Care, Degnon Contr. Co., New Paltz, N. Y. (*Jun., June 6, 1899*)	April 3, 1901
Keim, Warren Byron. Asst. Engr., Bridge and Constr. Dept., The Pennsylvania Steel Co., Steelton (Res., Camp Hill), Pa	Jan. 4, 1905
Keith, Charles Whiteside. Chf., Div. of Eng. Design, Bureau of Public Works, Manila, Philippine Islands	Mar. 7, 1906
Keith, Lorin Acil. 226 W. 5th St., Mansfield, Ohio	Oct. 2, 1907
Kelley, Matthew DeTobin. Cons. Engr., Wahaba, Wyo. (*Jun., Sept. 3, 1907*)	June 1, 1909
Kellogg, Albert Victor. Engr., M. of W., Morgan's Louisiana & Texas R. R. & S. S. Co., Louisiana Western R. R. Co., Texas & New Orleans R. R. Co., Galveston, Harrisburg & San Antonio Ry. Co., Houston, Tex.	Nov. 6, 1895
Kelly, William. Capt., Corps of Engrs., U. S. A., U. S. Engr. Office, Manila, Philippine Islands	Feb. 3, 1904
Kemp, John Edward. Civ. Engr., Kewanee Works, National Tube Co., Kewanee, Ill	April 1, 1908
Kempkey, Augustus, Jr. 721 Balboa Bldg., San Francisco, Cal. (*Jun., Mar. 31, 1903*)	Feb. 1, 1910
Keys, Edward Allen. Special Insp. to the Secy. of the Interior, Room 227, Federal Bldg., Spokane, Wash	July 9, 1906
Kiehm, Charles. 196 Central Ave., Albany, N. Y	Jan. 8, 1908
Killam, Charles Wilson. Asst. Prof. of Architectural Constr., Harvard Univ., 20 Walker St., Cambridge, Mass	Dec. 4, 1907
King, Clifford Marshall. City Engr., Sandusky, Ohio. (*Jun., Mar. 6, 1906*)	July 1, 1909
King, Everett Edgar. 717 East Buffalo St., Ithaca, N. Y	Nov. 7, 1906
King, Roy Stevenson. Mech. Engr., 252 Jefferson St., Valparaiso, Ind.	Jan. 4, 1910
Kinne, George Whitney. Erecting Dept., Am. Bridge Co. of N. Y., Room 209, Fuller Bldg., Jersey City, N. J	Dec. 5, 1906
Kinsey, William Ambrose. Contr. Engr., 192 Market St., Newark, N. J.	May 31, 1910
Kirby, Isaac Henry. Roslyn, Nassau Co., N. Y	Nov. 1, 1905
Kirchner, Paul Alois. 40 West 36th St., New York City	Sept. 6, 1905
Kirkham, John Edward. Associate Prof. in Civ. Eng., Iowa State Coll., 703 Kellog Ave., Ames, Iowa	Feb. 7, 1906
Kirkpatrick, Harlow Barton. Asst. Engr., The San. Dist. of Chicago, 1734 Ridge Ave., Evanston, Ill	Mar. 2, 1909
Kissack, Alfred Broughton. P. O. Box 446, Sherman, Tex	May 4, 1909
Kittredge, Harry Chandler. Engr., 815 German Insurance Bldg., Rochester, N. Y	Mar. 1, 1910
Kleinschmidt, Henry Schwing. P. O. Box 873, Salt Lake City, Utah. (*Jun., Mar. 1, 1904*)	Dec. 1, 1908
Klossowski, Theodore Julius. 1211 Fifth Ave., Spokane, Wash	April 6, 1904
Knap, Edgar Day. Asst. Engr., Dept. of Bridges, 179 Washington St., Brooklyn, N. Y. (*Jun., Dec. 1, 1896*)	Dec. 4, 1900
Knight, Earle Kelly. Vice-Pres. and Treas., The Jobson-Hooker Co., 1170 Broadway, New York City	Dec. 4, 1907
Knight, Frank Barr. Chicago Mgr. and Engr., Lidgerwood Mfg. Co., 1917 Fisher Bldg., Chicago, Ill	Sept. 4, 1901
Knoch, Julius James. Prof. of Civ. Eng., Univ. of Arkansas, Fayetteville, Ark	Oct. 2, 1901
Koch, John Christian. Draftsman, Bridge and Bldg. Dept., C., M. & St. P. Ry., 1259 Railway Exchange Bldg. (Res., 740 West 26th St.), Chicago, Ill	Jan. 4, 1910
Koenig, Arnold Charles. Cons. Engr., 550 Brandeis Theatre Bldg., Omaha, Nebr	Nov. 7, 1900
Kolb, Henry Jacob. Asst. Engr., Brooklyn Rap. Tran. System, 85 Clinton St., Brooklyn, N. Y. (*Jun., Feb. 3, 1903*)	April 4, 1906
Koon, Joseph Burr. 2524 Thirty-eighth St., Chicago, Ill	May 3, 1910
Koon, Ray Emerson. Associate with Burns & McDonnell, Civ., Hydr. and San. Engrs., 823 Scarritt Bldg., Kansas City, Mo	Oct. 7, 1908
Kreiner, Harry Peter. Surv. and Municipal Engr. (Borrie & Kreiner), 788 Broad St., Newark, N. J	Jan. 8, 1908

	Date of Membership
C. Krellwitz, Diedrich William. Bridge Designer, Public Service Comm., First Dist., 23 Flatbush Ave., Brooklyn, N. Y. (*Jun., Oct. 31, 1905*)	Feb. 2, 1909
Kreuger, Ivar. Contr. (Kreuger & Toll), Vasagatan 15, Stockholm, Sweden.	Dec. 7, 1904
Krone, Arnold Henry. Director and in Chg., Eng. Dept. of J. Henry Miller, Inc., 106 Dover St., Baltimore, Md.	May 31, 1910
Kyle, George Allen. Cons. Engr., 406 Railway Exchange Bldg., Portland, Ore	Feb. 2, 1892
Kyle, Ralph Briggs. 236 Fourteenth St., San Pedro, Cal	May 3, 1910
Lafler, William Arthur. Asst. Engr., New York State Barge Canal, P. O. Box 1208, Newark, N. Y.	May 4, 1909
Lamb, Ernest Avery. Res. Engr., Barge Canal Dredging Contracts, Sections Nos. 2 and 3, Res. Engr.'s Office, Guy Park House, Amsterdam, N. Y.	Sept. 7, 1904
Lamb, William Alfred. Asst. Engr., Water Resources, U. S. Geological Survey, Helena, Mont. (*Jun., Nov. 5, 1907*)	May 3, 1910
Lambert, Byron James. Prof. of Structural Eng., State Univ. of Iowa, Iowa City, Iowa	Jan. 5, 1909
Lambert, Wallace Corliss. Gleasondale, Mass	April 4, 1900
Lambie, Charles Sumner. Pres., The C. S. Lambie Co., Engrs. and Contrs., Wabash Bldg., Pittsburg, Pa. (*Jun., Oct. 1, 1901*)	Feb. 6, 1907
Lamont, Clarence Booth. Asst. to the Pres., The Moran Co. (Res., 1103 Cherry St.), Seattle, Wash	May 4, 1909
Lanagan, Frank Ray. Deputy City Engr. (Res., 273 Hamilton St.), Albany, N. Y. (*Jun., Sept. 5, 1905*)	Feb. 1, 1910
Lancashire, Forest Henry. Designing and Const. Engr., 842 Wilson Bldg., Dallas, Tex	July 10, 1907
Land, John Thomas. Designing Engr. and Draftsman, Florida East Coast Ry., St. Augustine, Fla	Oct. 4, 1910
Landers, Charles Scott. Care, Hildreth & Co., 135 Broadway, New York City	April 1, 1908
Lane, Edward Percy. Asst. Engr., N. Y. C. & H. R. R. R., 335 Madison Ave., Room 1221, New York City	Jan. 5, 1909
Lane, Edwin Grant. Engr., M. of W., Pittsburg System, B. & O. R. R., B. & O. Depot, Pittsburg, Pa	Jan. 8, 1902
Lang, Frank August. Asst. Supt. and Insp., U. S. Public Bldgs., 727 Custom House, New York City	Mar. 1, 1910
Lange, Theodore Ferdinand. Asst. Engr., N. Y. C. & H. R. R. R. Co., 443 East 138th St., New York City	Feb. 5, 1908
Lannan, Louis Edgar. Res. Engr., N. Y., W. & B. Ry. Co., Mt. Vernon (Res., 69 Hale Ave., White Plains), N. Y.	June 7, 1905
Larkins, Edgar Ernest. Office Engr., City Engr.'s Office; Civ. and Municipal Engr. (Consolidated Eng. Co.), 644 Bee Bldg., Omaha, Nebr.	Sept. 6, 1910
Larmon, Frank Perry. Supt., The Lovejoy Co., Cambridge, N. Y.	July 9, 1906
Larrison, George Kirkpatrick. Asst. Irrig. Engr., Irrig. Div., Bureau of Public Works, Manila, Philippine Islands	July 1, 1908
Larson, Clarence Melrose. Asst. Engr., Railroad and Tax Commissions, Madison, Wis	Oct. 7, 1908
LaRue, Eugene Clyde. Dist. Engr., Water Resources Branch, U. S. Geological Survey, Box 972, Salt Lake City, Utah	Jan. 4, 1910
Lasley, Charles Orton. Engr., The A. Bentley & Sons Co., Gen. Contrs., Toledo, Ohio	May 4, 1904
Lathrop, Jay Cowden. Care, William Fargo, Jackson, Mich	Oct. 2, 1907
Laurgaard, Olaf. Chf. Engr., Oregon, Washington & Idaho Finance Co., 503 Couch Bldg., Portland, Ore.	June 1, 1909
Lavelle, Thomas Monahan. Engr. with The Eastern Steel Co., Pottsville, Pa	Sept. 7, 1904
Law, Walter Hills. Woodside, N. Y.	May 31, 1910
Lawrence, Charles Walter. Prof., Civ. Eng., Univ. of Southern California, 1203 W. 36th Pl., Los Angeles, Cal	Jan. 8, 1908
Lawrence, Engelbert Conrad. Cons. Engr., Newport Contr. & Eng. Co., 428 East 22d St., Baltimore, Md	Nov. 8, 1909
Lawson, Lawrence Milton. Asst. Engr., U. S. Reclamation Service, Yuma, Ariz	Oct. 3, 1906
Lawton, Perry. 7 Savings Bank Bldg., Quincy, Mass. (*Jun., Jan. 3, 1893*).	Sept. 2, 1896
Lawton, Richard Mack. Asst. Engr., N. Y. C. & H. R. R. R., 335 Madison Ave., New York City	May 3, 1910
Lawton, Walter Luman. 85 West Cayuga St., Oswego, N. Y.	Mar. 5, 1902
Layng, Frank Rahn Shunk. Engr. of Track, Bessemer & Lake Erie R. R., Greenville, Pa. (*Jun., April 1, 1902*)	May 3, 1910
Leahy, Maurice Joseph. South Hadley Falls, Mass	Dec. 4, 1907
Leake, Boudinot Gage. Civ. Engr. and Archt., Room 20, Dundee Bldg., Fort Worth, Tex. (*Jun., Jan. 5, 1904*)	May 3, 1905
Leane, Walter Burditt. Chf. Engr., Ferrocarril Longitudinal, Seccion Norte, Augustinas 718, Santiago, Chili	Jan. 3, 1906

	Date of Membership
Lee, Augustine Leftwich. Asst. Engr., Am. Bridge Co., Ambridge, Pa.	Oct. 3, 1906
Lee, Elsworth Mortimer. (Lee & Hewitt, Engrs. and Archts.), 1123 Broadway, New York City	Mar. 7, 1906
Lee, Engbert A. Asst. Engr., Am. Smelting & Refining Co., Symes Bldg., Denver, Colo	Oct. 7, 1903
Lee, John Louis. Dist. Mgr., MacArthur Concrete Pile & Foundation Co., 321 Central Bldg., Seattle, Wash	April 3, 1907
Leefe, Frederick Ewbank. U. S. Junior Engr., U. S. Engr. Office, Marshfield, Ore	May 6, 1908
Leeper, John Bigger. Asst. Engr., Am. Bridge Co., Frick Bldg., Pittsburg, Pa	Jan. 3, 1900
Leeuw, Henry Alexander. Gen. Supt., Glyndon Contr. Co., Yorktown Heights, N. Y. (*Jun., Sept. 5, 1905*)	Oct. 5, 1909
Leighton, Marshall Ora. Chf. Hydrographer, U. S. Geological Survey (Res., 1759 Lanier Pl.), Washington, D. C	Oct. 4, 1905
Lemen, William Caswell Smith. U. S. Asst. Engr., U. S. Engr. Office, Brunswick, Ga	July 10, 1907
Letson, Thomas Herbert. 39 Cortlandt St., New York City. (*Assoc., Mar. 1, 1905*)	Mar. 2, 1906
Lewis, Arthur Stephen. Asst. Secy. and Supt., Lincoln Park System, Chicago, Ill	April 6, 1909
Lewis, Clarence McKenzie. Care, Wm. Salomon & Co., 25 Broad St., New York City	Dec. 3, 1902
Lewis, Clifford, Jr. Second National Bank Bldg., Utica, N. Y	Sept. 2, 1903
Lewis, John Howard. State Engr., Salem, Ore	Sept. 6, 1905
Lewis, Luther Hammond. Archt., 200 Fifth Ave., New York City	April 6, 1904
Lewis, Ransome Tedrowe. Mgr., Elmira Plant, Empire Bridge Co., Elmira, N. Y	June 6, 1906
Lewis, Walter Raleigh. Supt., Water-Works, City Hall, Trinidad, Colo.	May 3, 1905
Lex, Washington Irving. 1508 N. 19th St., Philadelphia, Pa	May 2, 1906
Lightfoot, William Joseph. U. S. Surv. and Special Disbursing Agt., Dept. of the Interior, General Land Office, Salt Lake City, Utah	Feb. 1, 1905
Linard, Drew Jones. Care, American Consulate, Ceiba, Honduras	July 10, 1907
Lincoln, Levi Bates. Locating Engr., Bangor & Aroostook R. R., Houlton, Me	Jan. 3, 1911
Lindau, Alfred Emanuel. Chf. Engr., Corrugated Bar Co., New Bank of Commerce Bldg., St. Louis, Mo	Jan. 3, 1906
Lindhé, John Birger. Civ. Engr., U. S. Engr. Dept., Burrwood, La.	Nov. 4, 1908
Lindholm, Carl Bertram. (Lindholm & Tuller), Agri. National Bank Bldg., Pittsfield, Mass	April 6, 1909
Lindsey, Kieffer. Civ. and Constr. Engr., 1 Third Ave., Rome, Ga. (*Jun., Oct. 7, 1902*)	Oct. 4, 1905
Lineberger, Walter Franklin. Cons. Civ. and Min. Engr., Care, Lineberger & Rone, Apartado 333, Torreón, Coahuila, Mexico	May 4, 1909
Linnell, Herbert Prescott. Chf. Engr., Atlantic, Gulf & Pacific Co., Manila, Philippine Islands	May 2, 1906
Little, George Kerr. U. S. Asst. Engr., Tuscaloosa, Ala	June 3, 1903
Livermore, Norman Banks. Pres., Norman B. Livermore & Co., Metropolis Bank Bldg., San Francisco, Cal. (*Jun., Dec. 5, 1899*)	Oct. 1, 1902
Lobo, Carlos. Asst. Engr., Dept. of Water Supply, Gas and Electricity, 13 Park Row, Room 2015, New York City (Res., 550 Seventh St., Brooklyn, N. Y.)	May 3, 1905
Lochridge, Elbert Emerson. Chf. Engr., Water Dept., 43 Bridge St., Springfield, Mass	May 3, 1905
Locke, William Willard. San. Insp., Met. Water and Sewerage Board, 4 Evergreen St., South Framingham, Mass	Oct. 6, 1897
Lockwood, Richard John. Chf. Engr., New Iberia & Northern R. R. Co., New Iberia, La	May 3, 1910
Loewenstein, Jacob. Am. Bridge Co., 30 Church St. (Res., 2 West 94th St.), New York City	Feb. 6, 1907
Logan, William Seeley. City Surv., 121 Midland Ave., Arlington, N. J.	April 6, 1904
Lombardo, Javier Diaz. Address unknown	Oct. 2, 1907
Long, Clarence Burton. Asst. Engr., U. S. Reclamation Service, Augusta, Mont	Nov. 8, 1909
Long, Eugene McLean. (Long & Miller, Cons. Engrs.), 220 Broadway, New York City	June 1, 1898
Long, John Coleman. Long Constr. Co., 106 R. A. Long Bldg. (Res., 3332 Summit St.), Kansas City, Mo	Jan. 8, 1908
Longley, Francis Fielding. Res. Engr., Toronto Filtration Plant, Toronto, Ont., Canada. (*Jun., Feb. 28, 1905*)	Mar. 2, 1909
Lorenz, George Benjamin. Asst. Engr. with George N. Randle, City Engr., 1826 G St., Sacramento, Cal	Jan. 4, 1910
Louckes, Frank Irwin. Junior Engr., U. S. Engr. Office, Box 72, Louisville, Ky	Jan. 3, 1911
Louwerse, Peter Martin. Trussed Concrete Steel Co., 145 Euclid Ave., West, Detroit, Mich	April 1, 1908

	Date of Membership
LOVE, ANDREW CAVITT. Gen. Supt., Beaumont Irrigating Co., Beaumont, Tex	Feb. 6, 1907
LOVELL, EARL BRINK. Prof., Civ. Eng., Columbia Univ.; Vice-Pres., Chas. Hansel & Co.; Mgr., Eng. Dept., Lawyers Title Insurance & Trust Co., New York City	April 4, 1906
LOVETT, GEORGE FREDERICK. City Engr., Berlin, N. H	Sept. 7, 1904
LOW, GEORGE EVARTS. 45 Broadway, New York City. (*Jun., Nov. 6, 1894*).	Mar. 2, 1898
LOWINSON, OSCAR. Cons. Archt. and Engr., 18 East 42d St., New York City. (*Jun., May 3, 1892*)	Feb. 7, 1900
LOWTHER, BURTON. Const. Engr., Water-Works Dept., 2608 Brooklyn Ave., Kansas City, Mo	Oct. 7, 1908
LUCAS, GEORGE LATIMORE. Asst. Engr., Public Service Comm., 154 Nassau St., New York City	Dec. 7, 1904
LUDLOW, JUSTIN WYMAN. Asst. Prof. of Structural Eng., Lewis Inst., Chicago, Ill. (*Jun., April 5, 1904*)	Mar. 1, 1910
LUDWIG, JULIUS ALFRED. 79 Wall St., New York City. (*Jun., May 31, 1892*)	Oct. 2, 1895
LUND, GEORGE ALFRED. Mgr., Post & McCord, 44 East 23d St., New York City	Nov. 7, 1894
LUND, ROBERT LEATHAN. Cons. Engr., 5968 W. Cabanne Pl., St. Louis, Mo.	May 4, 1904
LUNDOFF, CLEMENS WALDEMAR. Vice-Pres., Crowell & Sherman Co., 3111 Carnegie Ave., Cleveland, Ohio	June 3, 1908
LUSH, CUYLER WARFIELD. 535 West 163d St., New York City. (*Jun., Feb. 4, 1908*)	May 31, 1910
LYLE, WILLIAM THOMAS. Prof. of Municipal Eng., Lafayette Coll., Easton, Pa	Nov. 6, 1901
LYMAN, RICHARD ROSWELL. Cons. Engr.; Prof. of Civ. Eng., 34 Engineering Bldg., Univ. of Utah, Salt Lake City, Utah. (*Assoc., May 4, 1904*)	Feb. 2, 1909
LYNCH, TILLMAN DANIS. Research Engr., Westinghouse Elec. & Mfg. Co., 816 Wallace Ave., Wilkinsburg, Pa	Nov. 3, 1897
LYON, WALLACE CHITTENDON. Asst. Structural Engr., Care, Superv. Archt.'s Office, Washington, D. C	Feb. 6, 1901
LYTEL, JAMES LEONARD. Project Engr., Strawberry Val. Project, U. S. Reclamation Service, Provo, Utah	Jan. 4, 1905

MACARTNEY, MORTON. City Engr., 01209 Hollis St., Spokane, Wash	Mar. 2, 1909
MACCORNACK, CLYDE WEBSTER. Asst. Engr., Phœnix Bridge Co., 324 Gay St., Phœnixville, Pa. (*Jun., Jan. 31, 1905*)	Dec. 1, 1908
MACCRACKEN, GEORGE GERE. Gen. Mgr., MacCracken-Hauer-Terry Co., 13 Park Row, New York City. (*Jun., Feb. 5, 1901*)	Feb. 3, 1904
MACCREA, DON ALEXANDER. Cons. Engr. (Ford & MacCrea), Room 338, Gazette Bldg., Little Rock, Ark. (*Jun., May 2, 1899*)	Oct. 1, 1902
MACDONALD, ARCHIBALD ANGUS. Archt., 550 West 41st St., New York City. (*Jun., June 4, 1901*)	Oct. 5, 1904
MACGREGOR, JOHN GRANT. Chf. Engr., Alberta Central Ry., Red Deer, Alta., Canada	June 3, 1903
MACK, EDWARD R. Supt. of Parks, 806 Van Buren St., Wilmington, Del.	June 7, 1905
MACKENZIE, GEORGE RIDDICK. Civ. and Min. Engr., 1341 Arch St., Philadelphia, Pa	June 6, 1906
MACLAY, EDGAR GLEIM. Chf. Engr., The Am. Constr. Co., Houston, Tex.	Oct. 3, 1906
MACNAB, GEORGE TRAVILLA. Asst. Engr., Highways, Borough of the Bronx, 106 West 130th St., New York City	Feb. 3, 1897
MACNAIR, HENRY JAMES. Editor, Automobile Blue Book, 239 West 39th St., New York City	June 1, 1904
MACNAUGHTON, ERNEST BOYD. Pres. and Mgr., MacNaughton & Raymond, Inc., Archts.-Engrs., 606 Concord Bldg., Portland, Ore	Oct. 7, 1908
MACNEILLE, PERRY ROBINSON. Cons. Engr., 12 East 45th St., New York City. (*Jun., April 5, 1898*)	June 5, 1901
MACOMB, JOHN DE NAVARRE, JR. Lawrence, Kans	Oct. 5, 1904
MACY, ELBERT CLYDE. Supt. of Constr., Stone & Webster Eng. Corporation, Pike Bldg., Bellingham, Wash	Sept. 2, 1903
MCCAUSLAND, CHARLES PATTERSON. Field Bridge Engr., Western Maryland Ry., 709 Continental Bldg., Baltimore, Md	Dec. 6, 1910
MCCLELLAND, CLAUDE LESLIE. West 4th St., Ontario, Cal	Oct. 7, 1908
MCCLINTOCK, JAMES ROBINSON. Res. Engr., Hering & Fuller, P. O. Box 334, Clarksburg, W. Va. (*Jun., Oct. 2, 1906*)	May 3, 1910
MCCONNELL, IRA WELCH. Chf. Irrig. Engr., J. G. White & Co., Inc., Richfield, Idaho	Dec. 7, 1904
MCCONNELL, JOHN LORENZO. 5463 Jefferson Ave., Chicago, Ill. (*Jun., April 4, 1905*)	Jan. 2, 1907
MCCORD, JAMES BENNEY. 1 Broadway, New York City	Jan. 2, 1907
MCCORMICK, HERBERT GRANVILLE. Junior Engr., U. S. Engr. Office, Frankfort, Ky	April 1, 1908

	Date of Membership
McCoy, Charles Ephraim. Fraziers Bottom, Putnam Co., W. Va.	June 3, 1903
McCulloch, Richard. Asst. Gen. Mgr., United Rys. Co. of St. Louis, 3869 Park Ave., St. Louis, Mo.	Mar. 2, 1898
McCurdy, Harry Sherwood Royden. Div. Engr., Board of Water Supply of City of New York, Brown Station, N. Y.	Sept. 7, 1904
McDargh, Harry John. Asst. Engr., Bureau of Public Efficiency, 900 Masonic Temple, Chicago, Ill.	April 2, 1902
McDonough, Michael Joseph. Capt., Corps of Engrs. U. S. A., Fort Santiago, Manila, Philippine Islands	Jan. 2, 1907
McGeehan, Paul. 4323 Charlotte St., Kansas City, Mo.	July 10, 1907
McGonigle, Charles Joseph. Contr. Engr., Milliken Bros., Inc., 815 Chamber of Commerce Bldg., Portland, Ore.	May 6, 1908
McGregor, Robert Roy. Care, J. R. McGregor, Lompoc, Cal.	Mar. 6, 1907
McHarg, Leslie. Contr., 165 Broadway, New York City. (*Jun., Mar. 5, 1901*)	April 6, 1909
McKenzie, Thomas. Westerly, R. I. (*Jun., May 2, 1893*)	Nov. 6, 1895
McLachlan, Duncan William. Dept. of Rys. and Canals, Ottawa, Ont., Canada	Dec. 6, 1910
McLean, Joseph Patton. 68 Garrison Ave., Jersey City, N. J.	Mar. 2, 1904
McLoughlin, Joseph Navarre. Asst. Supt., Montana Div., Ore. Short Line R. R., Pocatello, Idaho	Nov. 1, 1910
McLure, Norman Roosevelt. Res. Engr., Phœnix Bridge Co. and Phœnix Iron Co., 527 Pierce Bldg., St. Louis, Mo. (*Jun., Feb. 6, 1906*)	Nov. 4, 1908
McMeekin, Charles William. Gen. Mgr., Crœsus Gold Min. & Milling Co., Plumbago, Alleghany P. O., Sierra Co., Cal. (*Jun., April 2, 1890*)	Mar. 7, 1894
McMenimen, William Vincent. 172 Fairview Ave., Jersey City, N. J. (*Jun., April 30, 1907*)	May 31, 1910
McMorrow, James Walter. Secy., McMorrow Eng. & Constr. Co., 3785 Broadway (Res., 560 West 157th St.), New York City	Oct. 7, 1908
McNary, Joseph Vance. Asst. Engr. in Chg. of Bridge Constr., Dept. of Public Works, Bureau of Constr., Pittsburg, Pa.	June 30, 1910
McNeil, Arthur James. Asst. Engr., Central Fuel Oil Co., Bartlesville, Okla. (*Jun., Mar. 6, 1906*)	Mar. 1, 1910
McPherson, Robert Henry. Engr., Robins Conveying Belt Co., Park Row Bldg., New York City	Jan. 4, 1905
Madden, John Henry. Asst. Div. Engr., Public Service Comm., First Dist., 308 West 30th St., New York City. (*Jun., Oct. 7, 1902*)	May 4, 1904
Magor, Henry Basil. Pres., Magor Car Co., 50 Church St., New York City. (*Jun., April 30, 1895*)	Mar. 7, 1900
Magruder, Frank Cecil. Engr., U. S. Reclamation Service, Belle Fourche, S. Dak. (*Jun., Sept. 6, 1904*)	Oct. 4, 1910
Mahon, Ross LeHunt. Care, Riverside Printing Co., Port Huron, Mich.	Feb. 1, 1910
Maier, Harry Ludwig. Asst. Engr., Street and Sewer Dept., 229 Connell St., Wilmington, Del.	June 5, 1907
Mair, John William. 100 West Lincoln Ave., Mt. Vernon, N. Y.	April 1, 1908
Malcolm, Charles Wesley. Asst. Prof. of Structural Eng., Univ. of Illinois, 908 W. Nevada St., Urbana, Ill. (*Jun., Sept. 4, 1906*)	April 6, 1909
Malukoff, Alexis Joseph. Asst. Engr., Dept. of Bridges, Park Row Bldg. (Res., 213 West 136th St.), New York City	Jan. 2, 1901
Manning, James Henry. Supt., Stone & Webster Eng. Corporation, Room 314, Odd Fellows' Bldg., Reno, Nev.	Jan. 3, 1911
Manning, William Sheppard, Jr. The Solvay Process Co., Syracuse, N. Y.	Sept. 6, 1905
Mansfield, Royal John. 49 Claremont Ave., New York City. (*Jun., Dec. 2, 1902*)	July 10, 1907
Manter, Ralph Barton. Care, Madeira-Mamoré Ry., Manãos, Brazil.	June 1, 1904
Mapes, Charles Maynard. Smith Bldg., 148th St. and Third Ave., New York City	July 10, 1907
Markwart, Arthur Hermann. (Galloway & Markwart), First National Bank Bldg., San Francisco, Cal.	July 9, 1906
Marquand, Philip. Allen, Sand & Co., Bankers, 44 Pine St., New York City	Oct. 5, 1898
Marsh, Francis Beal. Asst. Engr., Board of Water Supply, 165 Broadway, New York City. (*Jun., Oct. 2, 1906*)	Jan. 3, 1911
Marshall, Cyril Ernest Davis. Garden City, N. Y.	Mar. 6, 1907
Marshall, Thomas Clawson. Engr. and Contr., Goshen, N. Y.	May 4, 1909
Marshall, Thomas Worth. (Marshall & Marshall), 729 Fifteenth St., N. W., Washington, D. C.	June 3, 1908
Marshall, Urban Serenus. Engr. of the Colusa County Highway Comm.; City Engr., Box 96, Roseville, Cal.	Feb. 1, 1910
Martin, Bertrand Clifford. Asst. Dist. Engr., N. Y. C. & H. R. R. R. Co., 163 Flower Ave., East, Watertown, N. Y.	May 4, 1909
Martin, John. Engr. of Maintenance, Borough of the Bronx, Room 3, Third Ave. and 177th St., New York City	May 31, 1910
Martin, Richard Herbert. Prin. Asst. Engr., Florida East Coast Ry., P. O. Box 143, St. Augustine, Fla.	Oct. 4, 1910

	Date of Membership
Martin, Walter Irving. 5212 South Park Ave., Chicago, Ill.	April 1, 1908
Martin, William Franklin. Dist. Engr., U. S. Geological Survey, Executive Bldg., Honolulu, Hawaii. (*Jun., Mar. 5, 1907*)	Feb. 1, 1910
Martinez y Reugifo, Conrado Eugenio. 107 San Miguel St., Havana, Cuba	Oct. 7, 1908
Mason, Samuel Jefferson. City Surv.; (Mason & Smith), 102 Smith St., Perth Amboy, N. J.	Jan. 8, 1908
Massenburg, Walter Gray. Div. Engr., G. C. & S. F. Ry., Beaumont, Tex.	Jan. 2, 1907
Matheson, Ernest George. 512 Manhattan Ave., New York City	June 1, 1904
Matheson, John Douglas. Representative, Warren & Wetmore, Archts., New Union Terminal, Winnipeg, Man., Canada. (*Jun., Mar. 3, 1903*).	May 1, 1907
Matlaw, Isaac Solon. Asst. Engr., Bureau of Locks, New York State Barge Canal, Lyon Bldg., Albany (Res., 18 William St., Amsterdam), N. Y. (*Jun., Oct. 2, 1906*)	July 1, 1909
Matson, Jesse Sidwell. County Engr., Jefferson, Ohio	July 1, 1908
Matthes, François Emile. Topographic Insp., U. S. Geological Survey, Washington, D. C.	April 3, 1901
Maughmer, Carl. Asst. Engr., State Dept. of Eng., 1227 L St., Sacramento, Cal.	Jan. 4, 1910
Maupin, Edgar Staples. 1200 Grove St., Vicksburg, Miss. (*Jun., Sept. 5, 1905*)	Nov. 8, 1909
Mayhew, Alfred Boardman. Asst. Engr., U. S. Reclamation Service, Boise, Idaho	Nov. 8, 1909
Meadowcroft, William. Asst. Engr. (Designer), Board of Water Supply, 165 Broadway, New York City	Dec. 6, 1905
Means, Howard Chester. Supt. of Irrig., U. S. Indian Service, Fort Duchesne, Utah	June 30, 1910
Mears, Frederick. Chf. Engr., Panama R. R. Co., Cristobal, Canal Zone, Panama	Feb. 1, 1910
Meek, Gordon Stafford. Supt., Penn. & Lake Erie Dock Co., Fairport Harbor, Ohio	Oct. 4, 1905
Meem, James Lawrence. Civ. Engr. and Contr., 405 Washington St., Lynchburg, Va.	Oct. 4, 1910
Meggy, Robert Louis Gurdelston. North Ave. and Russell Rd., Fanwood, N. J.	Feb. 6, 1907
Melick, Neal Albert. Supt. of Constr., U. S. Public Bldgs., Davenport, Iowa. (*Jun., Dec. 2, 1902*)	July 9, 1906
Melius, Ludlow Lawrence. Care, Spuyten Duyvil Constr. Co., 271 West 125th St., New York City. (*Jun., May 2, 1899*)	Dec. 6, 1905
Melluish, James George. Civ. and San. Engr., 222 Unity Bldg., Bloomington, Ill.	June 7, 1905
Merrick, Howard B. Asst. Prof. of Surveying, Univ. of Michigan, 928 Church St., Ann Arbor, Mich.	July 1, 1909
Merrill, Ferrand Seymour. Designing Dept., Am. Bridge Co., 1421 Frick Bldg., Pittsburg, Pa.	April 5, 1910
Merrill, Ogden. Pres., Merrill-Ruckgaber Co., 50 Church St., New York City	Feb. 3, 1904
Merrill, Oscar Charles. Chf. Engr., U. S. Forest Service, 1204 First National Bank Bldg., San Francisco, Cal.	April 6, 1909
Mesa, Antonio Esteban. Oquendo 2 "A," Havana, Cuba	Jan. 1, 1896
Metzger, Fritz Louis. Civ. Engr., Cummings Structural Concrete Co., Pittsburg, Pa. (*Jun., Feb. 6, 1906*)	Jan. 31, 1911
Metzger, Louis Charles Frederick. Asst. Engr., Terminal R. R. Assoc. of St. Louis, 2650 Accomac St., St. Louis, Mo.	May 31, 1910
Meyers, Alfred Moyer. Architectural Engr., Kansas City Structural Steel Co., Kansas City, Mo.	Oct. 5, 1904
Meyers, Clarence William. Asst. Engr., Rapid Transit Subway Constr. Co., 314 Riverside Drive, New York City. (*Jun., Sept. 1, 1903*)	Oct. 2, 1907
Middleton, Robert James. Asst. Engr., B. and B. Dept., C., M. & St. P. Ry., 1313 Sherman Ave., Evanston, Ill.	Dec. 4, 1907
Miller, Clifford Neville. 24 Waterworks Bldg., Kansas City, Mo. (*Jun., June 4, 1891*)	Feb. 5, 1896
Miller, Crosby. Asst. Engr., Estimating Dept., Bridge and Constr. Dept., Pennsylvania Steel Co., Steelton, Pa. (*Jun., Jan. 7, 1908*)	Jan. 3, 1911
Miller, George Soter. 262 Pearl St., Burlington, Vt.	April 1, 1903
Miller, Hiram. City Engr., P. O. Box 916, Middletown, Conn.	Jan. 5, 1909
Miller, Lee Haun. Care, Bethlehem Steel Co., 1264 Ontario St., Cleveland, Ohio	Jan. 31, 1911
Miller, Max Merrill. Designer, Bridge Dept., N. Y. C. & H. R. R. R. Co., 335 Madison Ave., New York City (Res., Puritan Ave., Colonial Heights, Yonkers, N. Y.)	Oct. 7, 1908
Miller, Stanley Alfred. 1800 Monroe St., Paducah, Ky. (*Jun., Feb. 4, 1902*)	April 6, 1909
Miller, Walter Edward. Asst. Engr., R. R. Comm. of Wisconsin, Madison, Wis.	May 31, 1910
Miner, James Henry. Project Engr., U. S. Reclamation Service, Grand Junction, Colo. (*Jun., Mar. 31, 1903*)	Nov. 8, 1909

	Date of Membership
Minniss, George Stewart. (Ricker & Minniss, Engrs.), 702 Ellicott Sq., Buffalo, N. Y.	Dec. 5, 1906
Minor, Cyrus Edward. Asst. Engr. for Cananea Consolidated Copper Co., Box 150, Cananea, Sonora, Mexico	May 31, 1910
Mirick, Alfred Stowe. Asst. Engr., New York State Barge Canal, 144 Jay St., Albany, N. Y.	Oct. 5, 1909
Mitcham, George Nathan. Prof. of Civ. Eng., Alabama Polytechnic Inst., Auburn, Ala.	Nov. 8, 1909
Mitchell, Lester Hale. Care, U. S. Reclamation Service, Vandalia, Mont.	Oct. 5, 1909
Mitchell, Louis Adolph. Supt. of Roadway and Bldgs., Indiana Union Traction Co., Anderson, Ind.	May 31, 1910
Mobberly, Henry Peyton. Chf. Engr., Paris & Mt. Pleasant R. R., Paris, Tex.	April 3, 1907
Moler, William Griffith. Mgr., New York Office, Corrugated Bar Co., 1 Madison Ave., New York City	Jan. 3, 1900
Móller, Louis. Care, H. K. Clausen, 2041 Fifth Ave., New York City	May 1, 1907
Mönniche, Tollef Bache. Designing Engr., Dept. of Constr. and Eng., Isthmian Canal Comm., Culebra, Canal Zone, Panama	Oct. 3, 1906
Monsarrat, Nicholas Daubeney. Second Vice-Pres., Sunday Creek Co., Outlook Bldg., Columbus, Ohio. (*Jun., Feb. 5, 1895*)	Sept. 2, 1903
Montgomery, Ernest. 239 East 59th St., North, Mt. Tabor Station, Portland, Ore.	Oct. 5, 1909
Moody, Joseph Elbert. With Hurley, Mason Co., Engrs. and Contrs., Tacoma, Wash.	Oct. 7, 1908
Moore, Lewis Eugene. Asst. Prof. of Civ. Eng., Mass. Inst. Tech., 85 Washington Park, Newtonville, Mass. (*Assoc., April 1, 1908*)	April 5, 1910
Moorehead, Theodore Parker. Vice-Pres., H. L. Stevens & Co., 344 New York Blk., Seattle, Wash.	Oct. 5, 1909
Moorshead, Alfred Lee. Res. Engr., Bergen Hill Cut, Erie R. R., 649 Summit Ave., Jersey City (Res., 49 Locust Ave., Arlington), N. J.	April 3, 1907
Moorshead, Oliver. Chf. Engr., Central Kansas Interurban Ry. Co., Newton, Kans.	May 31, 1910
More, Charles Church. Associate Prof. of Civ. Eng., Univ. of Washington, University Station, Seattle, Wash. (*Jun., May 2, 1899; Assoc., Feb. 6, 1907*)	Mar. 31, 1908
Morey, Richard. Pres., Morey-Faulhaber Constr. Co., Chemical Bldg., St. Louis, Mo.	Jan. 2, 1901
Morgan, Arthur Ernest. Pres., Morgan Eng. Co., Cons. Engrs., 608 Goodwyn Inst. Bldg., Memphis, Tenn.	May 3, 1910
Moritz, Ernest Anthony. Sunnyside, Wash. (*Jun., Oct. 6, 1908*)	Jan. 4, 1910
Morrill, George Pillsbury. Ingeniero Primero de Obras Publicas, Sagua la Grande, Cuba	Jan. 2, 1907
Morrill, Wilbur Nathaniel. Managing Engr. for The Weber Co., Room 206, Courier Journal Bldg., Louisville, Ky.	Jan. 8, 1908
Morrison, Charles Edward. 50 Pine St., New York City	Oct. 5, 1909
Morrison, George Eldridge. City Engr., 1015 Douglas Ave., East Las Vegas, N. Mex.	Nov. 1, 1910
Morrison, James Luther. Civ. and Min. Engr. (Morrison Bros.), 27 Thornton Bldg., Bluefield, W. Va.	Nov. 4, 1908
Morrow, Frederick Edgar. Office Engr., C. & W. I. R. R., Dearborn Station (Res., 423 North Central Ave.), Chicago, Ill.	Nov. 8, 1909
Morse, Howard Scott. Res. Engr., Commrs. of Sewerage, 602 Equitable Bldg., Louisville, Ky.	Oct. 2, 1907
Morse, Robert Brooks. Asst. San. Engr., Metropolitan Sewerage Comm., 17 Battery Pl., New York City	June 30, 1910
Morssen, Charles Michael. 747 St. Catherine St., West, Room 24, Montreal, Que., Canada	June 5, 1907
Mosley, Earl Louis. Chf. Engr., Grand Junction & Grand River Val. Ry. Co., Grand Junction, Colo.	Sept. 6, 1910
Moss, Castle Prentice. Res. Engr. for Waddell & Harrington, 1486 Granville St., Vancouver, B. C., Canada	June 3, 1903
Moss, Robert Edward. Structural Engr., 126 Liberty St., New York City	May 2, 1900
Moss, Robert Faulkner. Care, Trussed Concrete Steel Co., Detroit, Mich. (*Jun., Nov. 1, 1904*)	Mar. 2, 1909
Mott, William Elton. Prof. of Civ. Eng., Carnegie Technical Schools, Pittsburg, Pa.	Mar. 5, 1902
Mould, George Alexander Hutchins. 540 Fourth St., Brooklyn, N. Y.	Dec. 7, 1904
Muller, Leslie. Rd. Engr., Hudson & Manhattan R. R., 137 Christopher St., New York City	Feb. 1, 1910
Munn, Alexander Majors. Secy., Callahan Bros., Munn & Reise, Daniels Bldg., Kansas City, Kans.	Jan. 3, 1906
Munn, Mortimer Adam. Pocantico Hills, N. Y.	July 9, 1906
Munroe, Hersey. Topographer, U. S. Geological Survey, Washington, D. C.	Mar. 5, 1902
Munson, John Gephart. Parksville, Tenn.	Sept. 6, 1910

	Date of Membership
Murphy, John Joseph. Asst. Engr., Topographical Bureau, Dept. of Public Works, 13 Park Row, New York City (Res., 70 Park Hill Ave., Yonkers, N. Y.)	Mar. 2, 1909
Murphy, Joseph Edgar. Office Engr., C., B. & Q. Ry., 209 Adams St., Room 63, Chicago, Ill	Sept. 2, 1903
Murphy, Robert Lincoln. Treas., Murphy Constr. Co., Murphy Bldg., East St. Louis, Ill	Nov. 7, 1906
Murray, Charles Warren. Vice-Pres. and Gen. Mgr., Carolina Constr. Co., Florence, S. C	Dec. 2, 1903
Murray, John Bonaventure. Engr., Fuller Eng. Co., 50 Church St., New York City	Sept. 6, 1910
Murray, Ray. 1024 Witherspoon Bldg., Philadelphia, Pa. (*Jun., Oct. 6, 1903*)	Dec. 4, 1907
Murray, Samuel. Bridge Engr., Oregon & Washington R. R., 636 Central Bldg., Seattle, Wash	Jan. 8, 1908
Myers, Chester John. Asst. Engr., N. Y. State, 15 N. Church St., Cortland, N. Y. (*Jun., Oct. 1, 1901*)	Jan. 4, 1905
Myers, Edward Warren. Civ. and Hydr. Engr., 346 Arcade Bldg., Greensboro, N. C	Oct. 2, 1901
Myers, John Hays. Engr., Second Div., Public Service Comm. for the First Dist., 2630 Broadway, New York City. (*Jun., Dec. 5, 1893*)	Oct. 5, 1898
Myers, John Henry. B. and C. Dept., Penna. Steel Co., Steelton, Pa	June 1, 1909
Myers, William Madison. With Va. State Highway Comm., Winchester, Va.	Oct. 3, 1906

Nagel, John. Supt., Manhattan Beach Estates, Manhattan Beach, N. Y.	June 30, 1910
Nash, Frank Dana. Div. Engr., Bureau of Public Works, Manila, Philippine Islands	May 4, 1909
Navarrete, Salvador Maria. Avenida Morelos 25, City of Mexico, Mexico.	Mar. 1, 1910
Neely, John Thompson. Res. Engr. and Supt. of Constr., Dept. of Gen. Contr., McClintic-Marshall Constr. Co., Pittsburg, Pa	Dec. 6, 1910
Neff, Frank Howard. Prof. of Civ. Eng., Case School of Applied Science, 2087 East 105th St., Cleveland, Ohio	May 6, 1903
Nelson, Alexander Howard. Atlantic City, N. J. (*Jun., Nov. 1, 1898*)	April 5, 1905
Nelson, Arthur Thomas. Mgr., Seattle Branch, Trussed Concrete Steel Co., 836 Henry Bldg., Seattle, Wash	Jan. 8, 1908
Nelson, Clarence Lotario. Care, Bailey Willis, Poste Restante, Buenos Aires, Argentine Republic	Oct. 3, 1906
Nelson, Fred Burgess. Asst. Engr., Dept. of Water Supply, New York City; Res., 18 Evergreen Pl., East Orange, N. J	April 6, 1909
Nelson, William. Gen. Mgr., The Georgian Mfg. Co., Binghamton, N. Y.	June 6, 1900
Neumeyer, Robert Engler. Borough Engr. of the Towns of Bethlehem and South Bethlehem, 501 Market St., Bethlehem, Pa. (*Jun., May 31, 1892*)	Mar. 3, 1897
Neville, Colone Will Jackson. (Neville & Swiler, Gen. Contrs.), 1020 Maison Blanche Bldg., New Orleans, La. (*Jun., Oct. 1, 1901*)	June 3, 1903
Newbegin, Parker Cleaveland. Maintenance Engr., Bangor & Aroostook R. R., Houlton, Me	May 1, 1907
Newberry, Spencer Baird. Vice-Pres. and Gen. Mgr., Sandusky Portland Cement Co., Sandusky, Ohio	Jan. 6, 1897
Newell, Herbert Damon. Engr., U. S. Reclamation Service, Hermiston, Ore	Dec. 7, 1904
Newell, Robert J. Asst. Engr., Twin Falls Salmon River Land & Water Co., Salmon River Dam, Rogerson, Idaho	Feb. 1, 1910
Newhall, William Barrett. Mgr., The Southern Fruit Lands Irrigating Co.; Cons. Engr., Raymondville, Tex	Oct. 7, 1908
Newman, Arthur Traver. With A. L. Webster, 82 Wall St., New York City.	Nov. 8, 1909
Newton, John Parsons. Asst Engr., Dept. of State Engr. and Surv., Barge Canal Office, Albany, N. Y	May 3, 1910
Newton, Samuel Donald. (Bentley & Newton), 422 Chadakoin Bldg., Jamestown, N. Y	June 1, 1909
Nial, William Augustine. With Nial Bros. Constr. Co., Troy, N. Y	July 9, 1906
Nichols, Clarence Hicks. Long Acre Hotel, 47th St., New York City	April 6, 1904
Nichols, Henry Francis. Gen. Mgr. and Engr., James Hill & Sons, 63 Grenfell St., Adelaide, South Australia	Oct. 1, 1902
Nicol, Walter Hilliard. City Engr., Tuscaloosa, Ala	June 30, 1910
Nicolaysen, Albin Georg. Special Asst., R. R. and Canal Revaluation State of New Jersey, 55 Broad St., Elizabeth (Res., 720 Leland Ave., Plainfield), N. J. (*Jun., Dec. 1, 1908*)	Oct. 4, 1910
Nikolitch, Milan. Hydr. Engr., 2211 Ellsworth St., Berkeley, Cal. (*Jun., Sept. 1, 1908*)	April 5, 1910
Nimmo, James Valence. Care, Canadian Northern Pacific Ry., 18 Hastings St., West, Vancouver, B. C., Canada	Sept. 5, 1906
Nixon, Courtland. Depot Quartermaster, Isthmian Canal Comm., Cristobal, Canal Zone, Panama	Nov. 1, 1905

	Date of Membership
NOBLE, CLARENCE WARREN. Contr. Fire-Proofing Engr., 117 Home Life Bldg., Toronto, Ont., Canada	Feb. 3, 1904
NOBLE, WALTER EDWIN. Asst. Engr., City Engr.'s Dept., City Hall, Fall River, Mass	April 2, 1902
NOERR, ROBERT COLLYER. (Greenwood & Noerr, Cons. Engrs.), 847 Main St. (Res., 120 Huntington St.), Hartford, Conn	Jan. 2, 1907
NOLAN, SIMON FRANK. Engr. in Bridge and Harbor Dept. of City Engr.'s Office (Res., 103 Bernon St.), Providence, R. I	April 5, 1910
NOLEN, WILLIAM ISAAC. Structural and Highway Bridge Engr., Copperhill, Tenn	May 3, 1910
NORCROSS, PAUL HOWES. 1622 Candler Bldg., Atlanta, Ga	July 9, 1906
NORCROSS, THEODORE WHITE. Dist. Engr., Forest Service, Majestic Bldg., Denver, Colo	Nov. 8, 1909
NORRIS, WALTER HENRY. Bridge Engr., Maine Central R. R., 238 St. John St., Portland, Me	Sept. 6, 1905
NORTH, ARTHUR TAPPAN. 510 Odd Fellows Bldg., St. Louis, Mo	Feb. 7, 1906
NORTHROP, ALBERT ALLEN. Care, Stone & Webster Eng. Corporation, Sumner, Wash	July 9, 1906
NOSKA, GEORGE ALBERT. Care, D. Everett Waid, 1 Madison Ave., New York City. (*Jun., Mar. 31, 1896*)	Sept. 3, 1902
NOYES, HARRY LINCOLN. Mech. Engr., Union Carbide Co., 79 Wall St., New York City	June 5, 1901
NYE, ALGERNON SIDNEY. 351 West 51st St., New York City (*Jun., July 2, 1890*)	April 5, 1905
OAKES, LUTHER STEVENS. Box 829, Centralia, Wash	Jan. 4, 1905
OAKLEY, GEORGE ISRAEL. Asst. Engr., Contract No. 30, N. Y. State Barge Canal, Herkimer, N. Y. (*Jun., Oct. 6, 1903*)	Nov. 6, 1907
OBREITER, JOSEPH WILLIAM. 908 Castle Point Terrace, Hoboken, N. J	Nov. 6, 1907
O'BRIEN, DANIEL BERNARD. Civ. Engr. and Contr., 1722 Park St., Syracuse, N. Y. (*Jun., April 3, 1906*)	May 3, 1910
O'CONNELL, GEORGE PAUL. Asst. Engr., Board of Water Supply, New York City, Brown Station, N. Y	Sept. 6, 1910
O'CONNOR, CORNELIUS JOSEPH. 770 East 179th St., New York City. (*Jun., Mar. 1, 1904*)	June 5, 1907
O'CONNOR, JOHN ADAM. Res. Engr., State Engr.'s Dept., Albany, N. Y	April 1, 1908
O'HARA, JOSEPH MATTHEW. Engr. in Chg. of S. P. Co. Testing Laboratory, 1109 Flood Bldg., San Francisco, Cal	June 30, 1910
O'HEARN, JOHN LYNCH. Cons. Engr., Clinton, Okla. (*Jun., Feb. 5, 1907*)	Nov. 4, 1908
OINOUYE, CHIKAO. Care, Koto-Kogio-Gakko, Sendai, Japan	Feb. 7, 1906
OLBERG, CHARLES REAL. Supt., Irrig., Indian Service, 522 Bumiller Bldg., Los Angeles, Cal	May 7, 1902
OLDER, CLIFFORD. Bridge Engr., Ill. Highway Comm., Springfield, Ill	Oct. 4, 1905
OLDS, CLARK. Erie, Pa	Mar. 1, 1899
OMBERG, JAMES ADOLPHUS, JR. Cons. Engr., 526 Goodwyn Inst. Bldg., Memphis, Tenn	April 1, 1903
O'NEIL, JOSEPH. City Engr., 608 Olive St., Leavenworth, Kans	Feb. 1, 1910
OPDYCKE, HENRY GORTON. 30 Church St., New York City	Sept. 7, 1904
ORR, ALEXANDER. Supt., Water-Works, Gloversville, N. Y. (*Jun., June 4, 1901*)	Feb. 5, 1902
ORTIZ, EDUARDO. 48 Avenida del 16 de Septiembre, City of Mexico, Mexico. (*Jun., Nov. 4, 1902*)	May 1, 1907
OSBORN, OLLIE STEELE. Care, Toltec Club, El Paso, Tex	Oct. 2, 1901
OSBORNE, GEORGE FREDERICK FOLGER. Capt., Royal Engrs., Care, Cox & Co., Fort Bombay, British India	Dec. 7, 1904
OSBOURN, HENRY VAN BUREN. 1650 Real Estate Trust Bldg., Philadelphia, Pa	Sept. 3, 1902
OTT, SAMUEL JACOB. Elm Ave., Hackensack, N. J	Feb. 6, 1907
OWEN, ARTHUR EDMUND. Prin. Asst. Engr., C. R. R. of N. J., 81 Grove St., Montclair, N. J	May 3, 1905
OWEN, ELIJAH HUNTER. Care, Development & Securities Co., Hippodrome Bldg., Cleveland, Ohio	June 6, 1906
OWENS, JAMES MICHAEL. Asst. Engr. in Chg., Dept. of Street Impvts., Office of City Engr., Board of Public Works, San Francisco, Cal. (*Jun., April 4, 1905*)	Jan. 8, 1908
PACE, FULTON. Engr. for Central Aguirre, Central Aguirre, Porto Rico. (*Jun., Nov. 5, 1907*)	Feb. 2, 1909
PADDOCK, HOWARD CHARLES. Designing Engr., The Turner Constr. Co., 11 Broadway, New York City	June 1, 1909
PAGET, CHARLES SOUDERS. Archt. and Engr. (Purnell & Paget), Thomeen, Canton, China	Nov. 1, 1910
PAIGE, JASON. Representative, Inter-Ocean Steel Co., 217 Railway Exchange, Chicago, Ill. (*Jun., Feb. 5, 1907*)	Feb. 2, 1909

ASSOCIATE MEMBERS P

	Date of Membership
Paine, Hibbard Atwill. Road Engr., Caroline County, Denton, Md.	Feb. 4, 1903
Palm, Thomas Jefferson. Res. Engr., Gulf, Colo. & Santa Fé Ry. Co., San Saba, Tex.	Oct. 4, 1910
Palmer, George Bruce. Right-of-Way Engr., Penn. Lines W. of Pitts., 1106 Union Station, Pittsburg, Pa.	April 6, 1909
Palmer, Marshall Barker. Asst. Engr., Syracuse Water Supply, 112 Court House (Res., 104 Amherst Ave.), Syracuse, N. Y.	June 5, 1907
Paquette, Charles Alfred. Asst. Chf. Engr., C., C., C. & St. L. Ry., Cincinnati, Ohio	April 6, 1898
Park, James Caldwell. 20 South Ave., Cranford, N. J. *(Jun., Feb. 28, 1905)*	June 3, 1908
Parker, Charles Frederic. Apartado 208, Durango, Dgo., Mexico. *(Jun., June 5, 1900)*	Sept. 2, 1903
Parker, James Lafayette. Prin. Asst. Engr. to Herbert C. Keith, 116 Nassau St., Room 901, New York City. *(Jun., April 2, 1907)*	May 3, 1910
Parker, John Castlereagh. Mech. and Elec. Engr., Rochester Ry. & Light Co., Rochester, N. Y. *(Jun., Dec. 6, 1904)*	May 6, 1908
Parker, Philip Á Morley. Care, Captain Parker, R. N., Philipsfield House, St. Michaels, Ashford, Kent, England	Mar. 6, 1907
Parker, Richard Denny. Engr., R. R. Comm. of Texas, Austin, Tex. *(Jun., June 3, 1902)*	Mar. 7, 1906
Parsons, Archibald Livingstone. Civ. Engr., U. S. N., U. S. Naval Academy, Annapolis, Md.	May 7, 1902
Parsons, Augustus Taber. Civ. Engr. and Surv. (Parsons & Barton), Box 435, Bakersfield, Cal. *(Jun., June 5, 1906)*	Oct. 4, 1910
Parsons, Charles Edward. 144 Edgewood Ave., Atlanta, Ga.	May 6, 1903
Parthesius, Philip Henry. Senior Eng. Examiner with New York State Civil Service Comm., 119 Fourth St., Troy, N. Y.	Nov. 1, 1910
Patch, Homer Austin. Contr. Engr., Minneapolis Steel Machinery Co., 313 E. P. & S. W. Bldg., El Paso, Tex.	Jan. 8, 1908
Patterson, Clair Brandon. With Pitts. & Shawmut R. R. Co., 2832 Fifth Ave., Beaver Falls, Pa.	July 1, 1909
Patterson, Robert Youngman. 1365 Meridian Pl., N. W., Washington, D. C.	Jan. 8, 1908
Pawling, George Franklin. Gen. Mgr., Bergdoll & Pawling, Engrs. and Contrs., Broad and Vine Sts., Philadelphia (Res, Ridley Park), Pa.	April 4, 1906
Payne, James Henry. 543 Pacific Elec. Bldg., Los Angeles, Cal.	Feb. 5, 1908
Peabody, Lionel Henry, Jr. Associate with O. Perry Sarle, 146 Westminster St., Providence, R. I. *(Jun., Feb. 6, 1906)*	Jan. 4, 1910
Pearse, Langdon. Asst. Engr. in Chg., Sewage Disposal Investigations, The San. Dist. of Chicago, 1500 Am. Trust Bldg., Chicago, Ill. *(Jun., Jan. 6, 1903)*	Oct. 7, 1908
Pease, Frederick Atwood. Gen. Mgr., The F. A. Pease Eng. Co., Williamson Bldg., Cleveland, Ohio	June 5, 1907
Peck, Ermon Miland. Engr. in Chg., Mech. Dept., Water-Works of Hartford, 260 Edgwood St., Hartford, Conn.	April 5, 1910
Peck, Myron Hall. Prof. of Civ. Eng., Imperial Pei-Yang Univ., Tientsin, China	Jan. 5, 1909
Peden, Leo Thomas. 3009 Bagby St., Houston, Tex.	May 31, 1910
Pellissier, George Edward. Supt., Goldschmidt Thermit Co., 90 West St., New York City. *(Jun., Feb. 28, 1905)*	July 1, 1909
Pendergrass, Robert Allen. Chf. Draftsman, McClintic-Marshall Constr. Co., Pittsburg, Pa.	June 3, 1908
Pendlebury, Edward. Asst. Engr., Public Service Comm., 154 Nassau St., New York City. *(Jun., Oct. 2, 1906)*	April 5, 1910
Peotter, Reuben Sylvester. Asst. Prof. of Civ. Eng., Polytechnic Inst. of Brooklyn; Hydr., San. and Irrig. Engr., 85 Livingston St., Brooklyn, N. Y.	Nov. 30, 1909
Perkins, Albert Henry. Div. Engr., New York State Water Supply Comm., Albany, N. Y.	Feb. 7, 1906
Perkins, Philo Sackett. Asst. Engr., N. Y., N. H. & H. R. R., 59 Chester Ave., Providence, R. I. *(Jun., Mar. 5, 1890)*	April 3, 1895
Perley, Alan Bigelow. Cons. Engr., 46 Gowen St., Mt. Airy, Philadelphia, Pa.	June 1, 1901
Perring, Henry Garfield. 5421 Vine St., Philadelphia, Pa.	Nov. 6, 1907
Perrot, Emile George. 1211 Arch St., Philadelphia, Pa.	Feb. 6, 1907
Perry, Francis William. Engr. in Chg. of Constr., Municipal Bldg., New York City (Res., 214 Parkside Ave., Brooklyn, N. Y.)	Jan. 5, 1909
Peters, Frederic Hatheway. With Dept. of Interior, Canada, P. O. Drawer V, Calgary, Alta., Canada	June 30, 1910
Peters, John Marvin. Asst. Engr., Mo. Pac. Iron Mountain System (Res., 5143 Maple Ave.), St. Louis, Mo. *(Jun., May 1, 1906)*	Nov. 1, 1910
Petersen, Charles Walter. Engr. of Track Elevation, Rock Island Lines, 802 La Salle St. Station, Chicago, Ill.	Feb. 6, 1907
Pettebone, Lauren Augustus. 307 Buffalo Ave., Niagara Falls, N. Y.	Feb. 2, 1909

	Date of Membership
Pfeifer, Herman Julius. Engr., M. of W., Terminal R. R. Assoc. of St. Louis, St. Louis Merchants Bridge Terminal Ry. Co., 2145 Blendon Pl., St. Louis, Mo	Sept. 6, 1899
Pfeiffer, George Whitfield. Supt., Spanish-American Iron Co., Santiago de Cuba, Cuba	Oct. 5, 1904
Pflueger, Alvin Cyrus. Asst. Engr., P. T. & T. R. R. Co., 345 East 33d St., New York City	June 5, 1907
Philbrook, Lee Elmo. 5427 Jefferson Ave., Chicago, Ill	May 3, 1910
Phillips, Howard Crathorne. Chf. Engr., A., T. & S. F. Ry., Coast Lines, Los Angeles, Cal. (*Jun., April 5, 1892*)	Sept. 6, 1899
Phillips, John Carleton. U. S. Junior Engr., Fort Flagler, Wash	Jan. 3, 1911
Phillips, Silas Bent. Engr. in Chg. of Design of Structures, Ore. & Wash. R. R., 632 Central Bldg., Seattle, Wash	Aug. 31, 1909
Phillips, Theodore Clifford. Civ. and Hydr. Engr., 523 East 34th St., Chicago, Ill	Mar. 2, 1904
Phillips, William Hale. Box 1023, Spokane, Wash. (*Jun., Nov. 1, 1904*)	May 4, 1909
Pickwick, Edwin Job. Engr. and Contr., Holland Patent, N. Y	Jan. 5, 1909
Pierce, George Abel. Draftsman, Mo. Pac. Ry., Room 801, Mo. Pac. Bldg., St. Louis, Mo	Jan. 5, 1909
Pierce, James Wilson. Durham, N. C	Feb. 3, 1904
Pike, Ralph Ashur. Designer, Public Service Comm., 127 N. High St., Mt. Vernon, N. Y. (*Jun., Mar. 6, 1906*)	Jan. 31, 1911
Pill, John Richards. Gen. Supt., Galloway Coal Co.; Vice-Pres. and Gen. Mgr., Choctaw Coal & Min. Co., 111 Twelfth Ave., South, Birmingham, Ala	Feb. 7, 1906
Pillsbury, George Bigelow. Capt., Corps of Engrs., U. S. A., West Point, N. Y	Dec. 7, 1904
Pires do Rio, José. 93 rua Quitanda, Rio de Janeiro, Brazil	Jan. 4, 1910
Pistor, George Emil John. Contr. Engr., Hay Foundry & Iron Works, 114 East 28th St., New York City. (*Jun., Dec. 3, 1901*)	July 10, 1907
Pitkethly, David Thomas. Asst. Engr., Bureau of Sewers, Borough of Brooklyn, 330 Etna St., Brooklyn, N. Y	April 6, 1909
Plock, Albert Francis. Chf. Engr., The Northwestern Iron Co., Mayville, Wis	Nov. 8, 1909
Plogsted, Walter John. Res. Engr., Gen. Ry. Signal Co., 55 Liberty St., Suite 2806, New York City. (*Jun., Oct. 6, 1903*)	May 4, 1909
Plummer, Horace Edwards. 497 East 27th St., Portland, Ore. (*Jun., April 30, 1907*)	Feb. 1, 1910
Podewils, Otto Charles Julius. Chf. Estimator, George A. Just Co., 1429 Prospect Ave., New York City	Jan. 3, 1911
Poe, Harry Tinker, Jr. 45 West Peachtree Pl., Atlanta, Ga	Feb. 5, 1908
Poe, Joseph Ralph. Civ. and Structural Engr., 1458 Lakewood Ave., Lakewood, Ohio	Feb. 5, 1908
Pohl, Charles Andrew. Care, John Bogart, 141 Broadway, New York City.	Oct. 2, 1907
Polk, Armour Cantrell. Asst. Engr., G. C. & S. F. Ry. Co., Box 358, Davis, Okla. (*Jun., Oct. 6, 1903*)	May 2, 1906
Pond, Harry Bradford. Edificio de la Mutua 401, City of Mexico, Mexico.	May 4, 1909
Poole, Charles Arthur. Engr., Ferguson Contr. Co., 50 Church St., New York City	June 5, 1907
Poole, John Hudson. Cons. Engr., 1216 Ford Bldg., Detroit, Mich	June 1, 1909
Popert, William Hopf. Contr. Engr., Am. Bridge Co. of N. Y., 906 Crocker Bldg., San Francisco, Cal	Nov. 4, 1908
Porter, James Madison. Prof., Civ. Eng., Lafayette Coll., Easton, Pa	May 4, 1892
Porter, Sam Graham. Chf. Engr., Arkansas Val. Sugar Beet & Irrigated Land Co., Holly, Colo	Oct. 2, 1907
Post, Chester Leroy. Supt. with The Unit Constr. Co., Holland Bldg., St. Louis, Mo	July 1, 1908
Post, William Schuyler. 1133 Forest Ave., Los Angeles, Cal	May 1, 1901
Potter, Alexander. Cons. Engr., 114 Liberty St., New York City. (*Jun., Jan. 4, 1888*)	Jan. 6, 1892
Potter, James Rowland. Civ. Engr. and Contr., 400 Coleman Bldg., Philadelphia, Pa	June 6, 1906
Powell, Thomas Jett. Surface Div., Engr. Dept., Dist. of Columbia (Res., 212 Thirteenth St., N. E.), Washington, D. C	Mar. 2, 1909
Pratt, Arthur Henry. Asst. Engr., Board of Water Supply of New York City (Res., 24 Summit Ave.), White Plains, N. Y	July 1, 1908
Pratt, Henry Blanchard. Asst. Engr., J. R. Worcester & Co. (Res., 750 Lexington St.), Waltham, Mass	June 1, 1909
Pratt, Joel Marsh. U. S. Asst. Engr., U. S. Engr.'s Office (Res., 24 South Catherine St.), Mobile, Ala	July 1, 1909
Prentice, William Hendry, Jr. Supt., Morey-Faulhaber Constr. Co., Chemical Bldg., St. Louis, Mo	April 4, 1906
Pressey, Henry Albert. Hibbs Bldg., Washington, D. C	May 1, 1901
Preston, Harry Longyear. Res. Engr., N. Y. C. & H. R. R. R. Co., Jordan, N. Y	April 1, 1908
Price, Paul Leon. With Raymond F. Almirall, Archt., Insp. on Emigrant Industrial Savings Bank Bldg., New York City	Oct. 3, 1906

	Date of Membership
Price, Philip Wallis. County Engr.'s Office, Court House, Pittsburg, Pa. (*Jun., April 2, 1901*)	Feb. 5, 1908
Priest, Benson Bulkeley. Care, Am. Bridge Co., 30 Church St., New York City	April 4, 1906
Prime, Alfred Coxe. Engr., P. R. R., 1008 Spruce St., Philadelphia, Pa.	Nov. 4, 1908
Prince, Arthur Dickson. Senior Asst. Div. Engr., Public Service Comm., First Div., 154 Nassau St. (Res., 274 West 94th St.), New York City. (*Jun., May 5, 1896*)	Oct. 3, 1900
Pritchard, Clifford Moses. Contr. Engr., Kansas City Structural Steel Co., 808 Herskowitz Bldg., Oklahoma, Okla	April 1, 1903
Pritchard, John Charles. Asst. Engr., Water Dept., 4245 Evans Ave., St. Louis, Mo. (*Jun., Sept. 1, 1908*)	Oct. 4, 1910
Pritchard, Philip Morris. Chf. Engr., United Alkali Co., Ltd., Widnes, Lancashire, England	June 6, 1900
Proctor, Lewis Jefferson. Gen. Agt., New Trinidad Lake Asphalt, Trinidad Lake Petroleum Co., and New York & Bermudez Co., Port of Spain, Trinidad	Mar. 1, 1905
Proctor, Ralph Fenno. P. O. Box 101, Canon City, Colo. (*Jun., June 3, 1902*)	Oct. 4, 1905
Prouty, Edward Nathan. Asst. Engr., M. of W. Dept., N. W. Pac. Ry., San Rafael, Cal	Feb. 3, 1904
Pullar, William Murray. St. Kitts, Essendon, Victoria, Australia	Aug. 31, 1909
Quimby, John Herman. 11 N. 18th St., East Orange, N. J	April 5, 1910
Quinby, Charles Edward. Chf. Engr. and Supt. of Constr., Ludlow Mfg. Co., Ludlow, Mass	Sept. 6, 1905
Quirk, James Francis. Asst. Engr., New York Board of Water Supply, Brown Station, N. Y	Jan. 3, 1911
Race, John Marble. Care, C. W. Leavitt, Jr., 220 Broadway, New York City	Mar. 5, 1902
Raider, Harry Adam. Res. Engr., Kwong Tung Yueh-han Ry. Co., Care, Am. Consulate, Canton, China	Nov. 1, 1910
Rainbow, John Roworth. Archt., 3 East 33d St., New York City	Jan. 6, 1904
Ramsey, Guy Robert. Orlando, Fla	Oct. 7, 1903
Randolph, John Hampden, Jr. Guild & Co., Charleston, S. C	Dec. 5, 1906
Randolph, Robert Isham. Secy., Internal Impvt. Comm. of Illinois, 748 First National Bank Bldg., Chicago, Ill. (*Jun., July 1, 1909*)	Nov. 1, 1910
Randorf, Charles Andrew. Structural Engr., Lackawanna Steel Co., Buffalo, N. Y	Dec. 6, 1910
Rankin, Harry Howard. Civ. and Min. Engr., 1321 Park Bldg., Pittsburg (Res., 5547 Raleigh St., Squirrel Hill), Pa	Mar. 1, 1905
Rannells, Clarence J. Little Hocking, Ohio	Oct. 3, 1906
Ranney, Charles Garfield. Asst. Engr., Dept. of State Engr. and Surv., Mohawk, N. Y. (*Jun., April 30, 1907*)	Feb. 1, 1910
Ranson, Birtram Willard. Gen. Delivery, Minneapolis, Minn. (*Jun., Sept. 3, 1907*)	Oct. 5, 1909
Rapalje, Herbert deWitt. Pres., Southern Map Co.; Cons. Civ. and Elec. Engr., 511 Southern Bldg., Wilmington, N. C	Sept. 6, 1910
Ravenscroft, Edward Hawks. 4757 E. Ravenswood Park, Chicago (Res., Glencoe), Ill	Nov. 6, 1907
Raynor, Clarence Webster. Chf. Engr., Coast Bridge Co., Suite 407, Ry. Exchange, Portland, Ore. (*Jun., Feb. 4, 1902*)	April 6, 1904
Reed, Alfred Clare. Supt., The Spanish-American Iron Co., Felton, Oriente, Cuba	June 5, 1907
Reed, William Belden, Jr. Vice-Pres. and Treas., The White Plains Constr. Co., 133 Railroad Ave., White Plains, N. Y. (*Jun., Dec. 1, 1896*)	June 5, 1907
Reedy, Oliver Thomas. Engr., U. S. Reclamation Service, Orman, S. Dak	June 6, 1906
Reel, Charles Gordon. Cons. Engr., Kingston, N. Y	June 5, 1907
Reeves, Carl Howell. Asst. Civ. Engr., Seattle Elec. Co., 4722 Latona Ave., Seattle, Wash. (*Jun., May 2, 1905*)	July 1, 1909
Reich, Phillip Jacob. Engr., Toledo Plant, Am. Bridge Co., Toledo, Ohio.	June 5, 1907
Reichardt, Walter Frederick. Cons. Engr., 102 Louisiana St., Little Rock, Ark. (*Jun., Jan. 31, 1905*)	July 10, 1907
Reid, Homer Austin. Asst. Engr., Bureau of Bldgs., Borough of Manhattan (Res., 628 West 147th St.), New York City	Dec. 4, 1901
Reimer, Arthur Adams. Engr., Water Dept., City Hall, East Orange, N. J	Mar. 6, 1907
Reimer, Frederic Adams. City Engr., 51 North Maple Ave., East Orange, N. J	April 6, 1909
Renshaw, Francis Orea. P. O. Box 539, Huntington, W. Va	Jan. 3, 1911

	Date of Membership
Reynolds, Justin Oakley. Engr. of Elev. Lines, Brooklyn Rapid Transit System, 85 Clinton St., Brooklyn, N. Y. *(Jun., Oct. 6, 1896)*	Dec. 5, 1900
Reynolds, Lafayette Clowe. Res. Engr., Pennsylvania Gen. Elec. Co. (Res., 628 West 10th St.), Erie, Pa. *(Jun., Feb. 6, 1906)*	Dec. 1, 1908
Rhett, Albert Haskell. Structural Engr., N. Y., Westchester & Boston Ry. Co., 65 Beaver St., New York City	Sept. 6, 1910
Rhoades, Theodore Eckford. Chf. Engr., Whitney-Steen Co., 1 Liberty St., New York City	June 1, 1909
Rhodes, Claude Irvin. 336 Capp St., San Francisco, Cal. *(Jun., Mar. 5, 1907)*	Mar. 1, 1910
Rhodes, Fred Dana. Cons. Engr., 140 Cedar St., New York City. *(Jun., June 6, 1899)*	Nov. 6, 1901
Rice, Guy Wickliffe. Chf. Engr., Oregon Val. Land Co. and Lakeview Irrig. & Power Co., Lakeview, Ore	May 3, 1910
Rice, Herbert Allan. Associate Prof., Civ. Eng., Univ. of Kansas, 1108 Ohio St., Lawrence, Kans	June 7, 1905
Rice, John Marie Thomas. Asst. Engr., Bureau of Water (Res., 5307 Butler St.), Pittsburg, Pa. *(Jun., April 2, 1907)*	Dec. 6, 1910
Rice, Ray Howard. Chf. Draftsman, Norfolk Southern R. R., Norfolk, Va.	July 1, 1909
Rich, Melvin S. 1448 Harvard St., Washington, D. C. *(Jun., Sept. 5, 1905)*	May 31, 1910
Richardson, James Herbert. Care, Engr. of Structures, N. Y. C. & H. R. R. R., Boston, Mass	Jan. 2, 1907
Richardson, John Francis. Care, U. S. Reclamation Service, Boise, Idaho. *(Jun., Oct. 3, 1899)*	June 5, 1907
Richardson, Rex Densmore. 1035 Woodlawn Ave., Scranton, Pa	Aug. 31, 1909
Richmond, Jackson Litton. (Skene & Richmond), 606 Victoria Bldg., St. Louis, Mo	Oct. 4, 1910
Richmond, Julian Pierre William. Asst. Engr., Board of Water Supply, 165 Broadway, New York City (Res., Dunwoodie Heights, Yonkers, N. Y.). *(Jun., Feb. 2, 1904)*	Dec. 4, 1907
Riedel, John Charles. Instr. of Mechanics, Cooper Union; Asst. Engr., Bureau of Sewers, 686 Halsey St., Brooklyn, N. Y	Oct. 4, 1905
Riegler, Louis John. Engr., Pennsylvania Co., Pittsburg (Res., Church Ave., Ben Avon), Pa	Sept. 3, 1902
Riggs, Thomas, Jr. Surv., Alaskan Boundary Survey, 2111 S St., N. W., Washington, D. C	April 6, 1909
Rightmire, Estel Dean. Atlantic City, N. J	Aug. 31, 1909
Rightor, Fred Elmer. Office Engr., Texas Bitulithic Co., El Paso, Tex	May 31, 1910
Rights, Eugene Jesse. 3806 Manayunk Ave., Wissahickon, Philadelphia, Pa	Mar. 2, 1909
Rights, Herbert Timothy. Hilldale Rd., Lansdowne, Pa	April 5, 1910
Ripley, Blair, Asst. Engr., Canadian Pacific Ry., Montreal, Que., Canada.	April 1, 1908
Ripley, Theron Monroe. Barge Canal Res. Engr., Fulton, N. Y	Nov. 6, 1901
Rittenhouse, Harvey. Engr., M. of W., C. & P. R. R., Box 604, Cumberland, Md. *(Jun., April 4, 1893)*	Dec. 7, 1898
Ritter, Rollin. Engr., U. S. Indian Irrig. Service, Black Rock, N. Mex.	May 31, 1910
Roach, James Howard. Div. Engr., Cleveland Short Line Ry., Cleveland, Ohio	April 5, 1910
Robb, Louis Adams. 71 Lincoln Park, Newark, N. J. *(Jun., May 5, 1903)*	Oct. 5, 1904
Robbins, Dana Watkins. Secy. and Engr., Spuyten Duyvil Constr. Co., 271 West 125th St., Room 213, New York City	Oct. 3, 1906
Robbins, Franklin Henry. Asst. Designing Engr., New York Board of Water Supply, 165 Broadway, New York City	July 10, 1907
Robbins, Hallet Rice. Civ. and Min. Engr., P. O. Box 51, Seattle, Wash. *(Jun., Nov. 5, 1907)*	Nov. 8, 1909
Roberts, Arthur Edwin. Structural Engr., 150 Nassau St., New York City (Res., 261 Clinton Ave., Jersey City, N. J.)	April 4, 1906
Roberts, Harry Ashton. Asst. Supt., Montana Div., Ore. Short Line R. R., Pocatello, Idaho. *(Jun., April 5, 1904)*	Dec. 5, 1906
Roberts, William Williams, Jr. Care, Turner Constr. Co., Hillburn, N. Y	Jan. 31, 1911
Robertson, Avalon Graves. Asst. Engr., Changuinola Ry., United Fruit Co., Bocas del Toro, Panama. *(Jun., Oct. 6, 1908)*	Jan. 3, 1911
Robinson, Edward William. Vice-Pres., Ruggles-Robinson Co., 45 East 42d St., New York City	Oct. 7, 1908
Robinson, Ernest Franklin. U. S. Engr. Office, Room 710, Army Bldg., New York City. *(Jun., Mar. 3, 1908)*	Oct. 4, 1910
Robinson, Frank Miner. Asst. Engr., West. Pac. Ry., Box 42, Portola, Cal	Jan. 2, 1907
Robinson, Harry Hayes. Asst. Engr., Maine Cent. R. R., Portland, Me.	May 4, 1904
Robinson, Herbert Fulwiler. Supt. of Irrig., U. S. Indian Service, Box 414, Albuquerque, N. Mex	July 10, 1907
Robinson, Holton Duncan. 357 West 121st St., New York City. *(Jun., Mar. 1, 1893)*	Jan. 3, 1894
Robinson, Reuben Totman. Res. Engr., Miami River Bridge, C., H. & D. Ry., 316 Dayton St., Hamilton, Ohio	Mar. 4, 1908

	Date of Membership
Rockenbach, Samuel Dickerson. Capt., 12th Cavalry, U. S. A., Fort Robinson, Nebr.	Feb. 6, 1901
Rockwell, Edward Henry. Prof. of Structural Eng., Tufts Coll.; Cons. Eng., Tufts College, Mass.	June 1, 1909
Rockwood, Edward Farnum. Chf. Engr., New England Concrete Constr. Co., 201 Devonshire St., Boston, Mass.	Oct. 5, 1909
Rodenbough, James Foster. Address unknown	April 3, 1907
Rogers, Augustus Webster. Standard Oil Co., Road Oil Dept., 28 Jackson St., Palmyra, N. Y.	Nov. 1, 1910
Rogers, Herbert Lincoln. Archt., Board of Water Supply, 299 Broadway, New York City	May 3, 1905
Rose, Rudolf Viedt. Eng. Asst., The Niagara Falls Power Co. and Canadian Niagara Power Co.; Res. Engr., Niagara Junction Ry. Co., Niagara Falls, N. Y.	April 5, 1905
Rosenberg, Friedrich. Engr., Charles L. Pitts Co., Contrs., 58 E. Park St., Newark, N. J. (*Jun., Oct. 2, 1889*)	Jan. 6, 1892
Rosenthal, Albert. Pres., Pelham Bay Chemical Co., 699 Broadway, New York City. (*Jun., Jan. 2, 1894*)	Nov. 6, 1901
Rosewater, William Marcus. Commercial Engr. with The Bucyrus Co., South Milwaukee, Wis.	June 5, 1901
Ross, Thomas Alexander. P. O. Box 185, B. P. O., Shanghai, China	Dec. 3, 1902
Roundey, Eugene Peronneau. Care, Rapid Transit Ry. Co., Syracuse, N. Y.	Jan. 6, 1904
Rousseau, Harry Harwood. Member, Isthmian Canal Comm.; Civ. Engr., U. S. N., Culebra, Canal Zone, Panama. (*Jun., June 6, 1893*)	April 4, 1900
Rousseau, William White. Supt. of Constr., Bureau of Water Supply, 47 State St., Troy, N. Y.	Dec. 1, 1908
Rowland, Walter. Draftsman, Isthmian Canal Comm., Corozal, Canal Zone, Panama	Dec. 1, 1908
Rue, Malcolm Asher. Chf. Engr., Robert Wilson Co., Engrs. and Contrs., 200 Fifth Ave., New York City	June 5, 1907
Rugg, Warren Fuller. Asst. Engr., N. Y. Board of Water Supply, 767 Elm St., Peekskill, N. Y.	Nov. 6, 1907
Ruggles, Charles Arner. Pres., Ruggles-Robinson Co., 45 East 42d St., Room 14, New York City	June 4, 1902
Runyon, William Kerper. 18 West Kinney St., Newark, N. J. (*Jun., April 5, 1898*)	Oct. 5, 1904
Rusch, Henri. 770 Bayard Ave., St. Louis, Mo.	Nov. 8, 1909
Rust, Henry Preston. Care, Vielé, Blackwell & Buck, 49 Wall St., New York City	Aug. 31, 1909
Ryan, Michael Healey. Asst. Engr., N. Y. Rapid Transit Comm., 231 West 125th St., New York City. (*Jun., Dec. 3, 1901*)	April 1, 1908
Ryan, Walter J. 303 East 6th St., York, Nebr. (*Jun., May 5, 1908*)	Mar. 1, 1910
Ryon, Henry. Morristown, N. J.	Jan. 31, 1911
Sabin, Alvah Horton. Chemist, 432 Sanford Ave., Flushing, N. Y.	Mar. 4, 1896
Sackett, Robert Lemuel. Prof. of Municipal and San. Eng. and of Hydraulics, Purdue Univ.; Cons. Engr., Lafayette, Ind.	Feb. 6, 1907
Sadler, Carl Leon. Topographer, U. S. Geological Survey, Washington, D. C.	April 1, 1908
St. Hill, Felix Perceval. Highbury, Longford, Tasmania	July 1, 1909
Sample, William Dwight. Twisp, Wash.	Dec. 1, 1908
Sampson, Cornelius Bramhall. Alamosa, Colo.	Oct. 5, 1909
Sanborn, James Forrest. Div. Engr., Board of Water Supply, New Paltz, N. Y.	May 4, 1904
Sanborn, Morton Franklin. Asst. Engr., Board of Water Supply of New York City, P. O. Box 203, Valhalla, N. Y.	Mar. 1, 1910
Sanders, Francis Nicoll. 235 State St., Albany, N. Y.	Sept. 3, 1902
Sanderson, Nathan Herbert. Asst. Engr. with Boston Bridge Works, Inc., 47 Winter St., Boston, Mass.	Feb. 1, 1905
Sanford, Harry Charles. Treas. and Chf. Engr., Degnon Contr. Co., 60 Wall St., New York City	Oct. 5, 1898
Sanford, Walter Edward. 67 Cook Ave., Elmhurst, N. Y.	Nov. 30, 1909
Sanger, Edmund Phipps. 154 West 121st St., New York City	Feb. 2, 1909
Saph, Augustus Valentine. 2330 Durant Ave., Berkeley, Cal. (*Assoc., Oct. 1, 1901*)	June 4, 1907
Sargent, Arthur Winthrop. Junior Engr., U. S. Engr. Office, Seattle, Wash.	Sept. 6, 1905
Sargent, Joseph Andrews. Eng. Adviser, Northwest Co., Inc., 1018 Board of Trade Bldg., Portland, Ore.	Oct. 2, 1901
Sarr, Fred Winton. Div. Engr., N. Y. State Highway Dept., Griffin Bldg., Syracuse, N. Y.	May 3, 1905
Saucedo, Vicente. Chf. Engr., Monterrey Elev. Ry., Light & Power Co. and Monterrey Water-Works & Sewer Co., P. O. Box 291, Monterey, N. L., Mexico. (*Jun., Oct. 6, 1903*)	May 3, 1910
Sauerman, Henry Burger. Coaling Station Engr., 914 East 66th St., Chicago, Ill.	May 1, 1907

	Date of Membership
Saunders, George Crosby. With Dietrich Bros., 346 North St., Baltimore, Md.	Mar. 1, 1905
Saunders, Henry Jenness. Res. Engr., The Arnold Co., Valier, Mont.	May 3, 1910
Saunders, Walter Bowen. Care, Western States Gas & Elec. Co., Stockton, Cal.	Jan. 4, 1910
Savage, John Lucian. I. O. O. F. Bldg., Boise, Idaho	May 1, 1907
Savage, Seward Merrill. Res. Engr., Barge Canal, 196 Genesee St., Utica, N. Y.	April 1, 1908
Sawtelle, Harry Francis. Asst. Engr., Cambridge-Main St. Subway, Boston Elev. Ry. Co.; Res., 65 Dana St., Cambridge, Mass.	Mar. 6, 1907
Sawyer, Donald Hubbard. Treas., Northwestern Eng. Corporation, 316 Wells-Fargo Bldg., Portland, Ore.	April 6, 1909
Sawyer, Francis Murphy. Asst. Engr., Constr., P. R. R. Co., Box 285, Swarthmore, Pa.	June 6, 1906
Sawyer, George Loyal. Secy., Northwestern Eng. Corporation, 410 Lindelle Blk., Spokane, Wash.	Jan. 8, 1908
Sawyer, Percy. Contr., Waukesha, Wis. *(Jun., Sept. 4, 1906)*	Jan. 4, 1910
Sawyer, Wilbur Cyrus. Draftsman, City Engr.'s Office, 618 South Olive St., Los Angeles, Cal. *(Jun., Oct. 6, 1903)*	Sept. 6, 1905
Sayers, Edward Lawrence. Office Engr. with Noble & Woodard, Cons. Engrs., 7 East 42d St., New York City. *(Jun., Feb. 2, 1904)*	Jan. 3, 1911
Scammell, John Kimball. Res. Engr., Public Works, Canada, Box 321, Saint John, N. B., Canada	June 4, 1902
Schaeffler, Joseph Carl. Archt. and Engr., 73 Tremont St., Boston, Mass. *(Jun., Feb. 28, 1905)*	June 5, 1907
Scharschmidt, Samuel Howard. 1327 Mason St., Elkhart, Ind.	May 1, 1901
Schermerhorn, Harvey Obed. Res. Engr., Residency No. 1, Erie Canal, Waterford, N. Y.	Mar. 1, 1910
Schermerhorn, Richard, Jr. 29 Broadway, New York City	July 9, 1906
Scheuermann, Hugo Julius. Bridge Designer, Barge Canal Office, Albany, N. Y.	Dec. 7, 1904
Schmitt, Ewald. Care, Light House Establishment, Office of Engrs., 12th Dist., Honolulu, Hawaii	Feb. 7, 1900
Schmitz, Frank Curtiss. Care, I. T. Williams & Sons, 25th St. and 11th Ave., New York City	Dec. 6, 1899
Schneider, Anton. Supt., Pierce Phosphate Co.; Supt., The Pebbledale Phosphate Co., Pierce, Fla.	May 4, 1898
Schneider, Herman. Dean of the Eng. Coll., and Prof. of Civ. Eng., Univ. of Cincinnati, Cincinnati, Ohio	April 2, 1902
Schoder, Ernest William. Willard Ave., Ithaca, N. Y. *(Jun., Oct. 1, 1901)*	Jan. 2, 1907
Schrader, Frederick Adolph. Supt., John Monks & Sons, Inc., Gen. Contrs., 82 Beaver St., New York City	Jan. 4, 1910
Schreiber, Herman Victor. Managing Engr., Sellers & Rippey, 1301 Stephen Girard Bldg., Philadelphia, Pa.	Mar. 1, 1910
Schubert, Charles Wesley. Structural Engr., Estimating Dept., The Brown Hoisting Machinery Co. (Res., 1226 East 112th St.), Cleveland, Ohio	Aug. 31, 1909
Schuchart, Paul August. Cons. Engr., 115 Nassau St., New York City.	Feb. 7, 1906
Schuyler, Philip. 630 First National Bank Bldg., Oakland, Cal.	May 31, 1910
Schwarze, Carl Theodore. Asst. Prof. of Civ. Eng., Cooper Inst., New York City (Res., 111 Sherman Pl., South Orange, N. J.)	May 1, 1907
Schwiers, Frederick William. Contr. Engr., 208 West 104th St., New York City. *(Jun., June 5, 1900)*	Jan. 7, 1903
Scott, Albert Lyon. 93 Federal St., Boston, Mass.	Nov. 7, 1906
Scott, Charles Bruce. Asst. Engr., State Highway Comm., P. O. Box 181, Lynchburg, Va.	Feb. 3, 1904
Scott, Guy. Div. Engr., Toledo Div., Penna. Lines West of Pitts., Toledo, Ohio. *(Jun., Dec. 1, 1903)*	Feb. 5, 1908
Scott, John Kuhn. Asst. Purchasing Agt., West. P. R. R., Room 803, Pittsburg Bank for Savings Bldg. (Res., 905 Heath St.), Pittsburg, Pa. *(Jun., Oct. 1, 1907)*	Dec. 6, 1910
Scott, William Fry. Cons. Engr.; Archt., Drawer H, Dunnville, Ont., Canada	Oct. 7, 1908
Scrimshaw, James Frederick. Vice-Pres., Salmond Bros. Co., Gen. Contrs., 526 Elm St. (Res., 76 Bennett Ave.), Arlington, N. J.	Jan. 8, 1908
Seabury, George Tilley. Asst. Engr. with Board of Water Supply, Valhalla (Res., 135 South Broadway, White Plains), N. Y. *(Jun., Mar. 31, 1903)*	Dec. 1, 1908
Searle, Charles Depew. Asst. Div. Engr., Public Service Comm., First Dist., 517 West 113th St., New York City	April 5, 1905
Searle, Lewen Firth. Asst. Engr., Board of Water Supply, New York City, Brown Station, N. Y.	May 6, 1908
Sears, Robert Humphry. Dist. Engr., East Indian Ry., Calcutta, India.	Dec. 4, 1901
Sears, Thomas Bartlett. Associate Prof. of Ry. Eng., Univ. of California, Berkeley, Cal.	Oct. 5, 1904

	Date of Membership
SEARS, WALTON HARVEY. With Lockwood, Greene & Co., 93 Federal St., Boston, Mass	April 5, 1910
SEASTONE, CHARLES VICTOR. Prin. Asst. to D. W. Mead, Cons. Engr., 530 State St., Madison, Wis	Dec. 5, 1906
SEAVER, CLIFFORD. Asst. Engr. Designer, Board of Water Supply, 165 Broadway, New York City	Dec. 6, 1910
SEERY, FRANCIS JOSEPH. Asst. Prof. of Civ. Eng., Coll. of Civ. Eng., Cornell Univ., 25 Willard Ave., University Pl., Ithaca, N. Y	April 3, 1907
SEKIBA, SHIGEKI. Chf. Engr., Yokogawa Bridge Works, Sakaigawa St., Nishiku, Osaka, Japan	Oct. 2, 1907
SELMER, JENS KRISTIAN. Sten Storegaten No. 6, Göteborg, Sweden	Nov. 7, 1906
SENIOR, FRANK SEARS. With Arthur McMullen & Co., Montgomery, N. Y. (*Jun., Feb. 28, 1899*)	Feb. 5, 1908
SENIOR, SAMUEL PALMER. Engr. and Supt., Bridgeport Hydr. Co., 820 Main St. (Res., 2121 North Ave.), Bridgeport, Conn	Oct. 7, 1903
SESSER, JOHN CORNELIOUS. Care, G. N. Ry. Office, St. Paul, Minn. (*Jun., Sept. 5, 1899*)	April 1, 1903
SEVERSON, OSCAR MELVERN. Asst. Engr., State Highway Comm., Falconer, Chautauqua Co., N. Y	Dec. 6, 1905
SEYFERT, EDGAR ERNEST. Chf. Engr., Pittsburg Steel Products Co., 1902 Frick Bldg., Pittsburg, Pa	July 9, 1906
SHANER, HARRY LINDEN. City Engr.; Chf. Engr., Gravity Water Supply, Lynchburg, Va	Dec. 7, 1904
SHAW, ARTHUR MONROE. Engr. and Res. Mgr., Phillips Land Co., 323 Hibernia Bldg., New Orleans, La	Jan. 3, 1906
SHAW, DAVID JOSEPH. Chappaqua, Westchester Co., N. Y. (*Jun., April 4, 1905*)	Mar. 6, 1907
SHAW, FRANK HAROLD. Engr., Water and Sewer Commissions, 503 Woolworth Bldg., Lancaster, Pa	Oct. 4, 1905
SHAW, GEORGE HERBERT. Asst. Engr., Board of Water Supply of New York City, 165 Broadway, New York City	April 5, 1910
SHAW, WILLIAM THOMAS. Asst. Engr., Boston Elev. Ry., 1822 Beacon St., Brookline, Mass	June 30, 1910
SHEARER, CHARLES ENGLISH. Structural Engr., Randolph Bldg., Memphis, Tenn	Dec. 6, 1910
SHEDD, GEORGE GARNETT. Supt. and Engr., J. G. White & Co., Inc., Bonny Eagle, Me	Oct. 3, 1906
SHEFFIELD, EDWARD NEWTON. Asst. Engr., Conn. Co., Office Bldg., New Haven, Conn	April 5, 1910
SHELDON, CHARLES SMITH. First Asst. Engr., C., H. & D. Ry., Cincinnati, Ohio	June 7, 1905
SHELDON, PAUL. Secy. and Treas., Buck & Sheldon, Inc., 60 Prospect St., Hartford, Conn	Oct. 5, 1909
SHELEY, HORACE WEST. Cons. Engr., P. O. Box 34, Salt Lake City, Utah. (*Jun., Sept. 5, 1905*)	July 1, 1909
SHELLENBERGER, LEIDY RUDY. Asst. Engr. for Grand Central Station Archts., 19 East 42d St., Bayonne N. J	May 2, 1900
SHELMIRE, ROBERT WARREN. 2752 North 12th St., Philadelphia, Pa	Nov. 30, 1909
SHEPARDSON, JOHN EATON. Res. Engr., Carolina, Clinchfield & Ohio Ry. (Res., 514 East Wataugo Ave.), Johnson City, Tenn	Jan. 7, 1903
SHERTZER, TYRRELL BRADBURY. Eng. Draftsman, Public Service Comm. for First Dist., 565 Fifth Ave., Brooklyn, N. Y	Oct. 5, 1904
SHIMA, TAKEJIRO. The South Manchuria Ry. Co., Dairen, China	Mar. 4, 1903
SHIPMAN, CHARLEY EVANS. Engr. with The Gerharz Eng. Co., Box 225, Billings, Mont. (*Jun., April 3, 1906*)	Nov. 4, 1908
SHIRE, MOSES EDMUND. Gen. Supt., Hirsh Stein & Co., Hammond, Ind. (*Jun., April 2, 1901*)	Jan. 4, 1905
SHOECRAFT, EZRA COLLIN. City Engr., La Porte, Ind	Sept. 6, 1910
SHOEMAKER, HARRY IVES. Care, Mindoro Development Co., Manila, Philippine Islands	May 4, 1909
SHONK, JOHN JENKS. Engr. and Contr., 1002 W. Broad St., Bethlehem, Pa.	Oct. 5, 1909
SHORT, WILLIAM AMBROSE DUDLEY. Chf. Engr., The Continental Signal Co., 46 East Van Buren St., Chicago, Ill	Feb. 5, 1902
SHORTT, JOHN HAGGERTY. 29 Augusta St., Hamilton, Ont., Canada	June 7, 1905
SHRYOCK, JOSEPH GRUNDY. Designing Engr., Belmont Iron Works, 22d St. and Washington Ave., Philadelphia, Pa. (*Jun., April 2, 1901*)	Dec. 5, 1906
SICKMAN, ALBERT FRANKLIN. Hydr. Engr., Holyoke Water Power Co., Holyoke, Mass	Mar. 4, 1903
SIKES, ZENAS HARRISON. Asst, Engr. of Structures, N. Y. C. & H. R. R. R., Grand Central Terminal, New York City	June 30, 1910
SIMPSON, ERASTUS ROLAND. 89 St. Bololph St., Boston, Mass	Nov. 4, 1903
SIMPSON, GEORGE. Chf. Engr., Thompson-Starrett Co., 51 Wall St., New York City	April 4, 1900
SIMPSON, PAUL DYER. Sullivan Harbor, Me	Feb. 6, 1907
SIMS, STUART. Designing Engr., Green River Gravity Water Supply, Tacoma, Wash	July 1, 1909

	Date of Membership
Sinnickson, George Rosengarten. Penna. R. R. Office, Paoli, Pa. (*Jun., Sept. 5, 1899*)	Feb. 6, 1907
Sisson, George Arthur. Supt., Div. 3, Dalles-Celilo Canal, U. S. Engr. Office, Big Eddy, Ore. (*Jun., April 30, 1907*)	Oct. 5, 1909
Sitt, William Theodore. Cons. Engr., Wells Bros. Co. of New York, 366 Fifth Avenue, New York City	June 7, 1905
Skelly, James William. Asst. Engr., U. S. Engr. Office, Custom House, St. Louis, Mo. (*Jun., May 2, 1899*)	April 1, 1903
Skillin, Edward Simeon. Second Vice-Pres., The Snare & Triest Co., 143 Liberty St., New York City	Dec. 1, 1908
Skinner, Frederick Gardiner. 2103 Carey Ave., Cheyenne, Wyo	Sept. 4, 1907
Slattery, Lawrence Patrick. Asst. Engr. with J. E. Sirrine, Greenville, S. C	Feb. 1, 1910
Slayton, Charles Albert. Chf. Engr., Winnipeg, Salina & Gulf Ry. Co., Salina, Kans	April 2, 1902
Slocum, Curlys Lyon. Eng. Dept., Long Island R. R., Jamaica (Res., Lynbrook), N. Y. (*Jun., Jan. 3, 1905*)	July 9, 1906
Slocum, Harry Spencer. Care, Vielé, Blackwell & Buck, 49 Wall St., New York City	Nov. 1, 1910
Smiley, Grier Ralston. Div. Engr., Florida East Coast Ry., Key West Extension, Key West, Fla	April 1, 1908
Smith, Albert. Civ. and Min. Engr., Saltsburg, Pa	Jan. 6, 1892
Smith, Albert Henry. Cons. Engr., 322 The Nasby, Toledo, Ohio	Oct. 2, 1901
Smith, Albert Orange. Civ. and Landscape Engr.; Supt. of Highways, Suffolk County, Port Jefferson, N. Y. (*Jun., May 2, 1905*)	Feb. 2, 1909
Smith, Charles Bailey. Chf. Engr., Salmon River Canals, Twin Falls Salmon River Land & Water Co., Twin Falls, Idaho	Jan. 3, 1906
Smith, Charles Vernon. Chf. Draftsman, Hudson & Manhattan R. R., 30 Church St., New York City	Dec. 5, 1906
Smith, Chester Alexander. 823 Scarritt Bldg., Kansas City, Mo	April 5, 1910
Smith, Chester Wason. 600 North Third St., Phœnix, Ariz	Oct. 5, 1904
Smith, Courtland Elmore. Asst. Engr. in Chg., Main Dam, Croton Falls Reservoir, P. O. Box 156, Brewster, N. Y	Mar. 1, 1905
Smith, Donald David. Gen. Mgr., Donald D. Smith Co., Gen. Contrs. and Engrs., 810 Surety Bldg., Muskogee, Okla	Sept. 6, 1910
Smith, Edgar Field. Asst. Engr. Designer, Board of Water Supply, 165 Broadway, Room 725, New York City	May 1, 1907
Smith, Edgar Maverick. M. of W. Device & Eng. Co., 9 East 30th St., New York City	Dec. 2, 1903
Smith, Eliot Nichols. Board of Water Supply, Poughkeepsie, N. Y. (*Jun., April 2, 1907*)	June 30, 1910
Smith, Forrest Leigh. Township Engr., 102 Smith St., Perth Amboy, N. J. (*Jun., April 30, 1907*)	Nov. 8, 1909
Smith, George Edson Philip. Irrig. Engr., Univ. of Arizona, Tucson, Ariz. (*Jun., Feb. 3, 1903*)	Sept. 6, 1905
Smith, Julian Chatard. Pres. and Mgr., Vacuum Specialty Co., 624 First Ave., New York City	Oct. 2, 1907
Smith, Karl Garthwaite. Contr. Engr., 857 Broad St., Newark, N. J.	May 3, 1910
Smith, Leonard Sewall. Associate Prof. of Topographic and Rd. Eng., Univ. of Wisconsin, Madison, Wis	June 2, 1897
Smith, Lloyd Bown. Engr., The Topeka Bridge & Iron Mfg. Co., Topeka, Kans	April 6, 1904
Smith, Pemberton. South American Representative, U. S. Steel Products Export Co., 544 Bartolomé Mitre, Buenos Aires, Argentine Republic. (*Jun., Mar. 31, 1891*)	April 4, 1894
Smith, Russell Biddle. 1020 Land Title Bldg., Philadelphia, Pa	May 6, 1908
Smith, Thomas Arthur. Gen. Supt., Turner Constr. Co., 11 Broadway, New York City	April 6, 1909
Smith, Travis Logan, Jr. Civ. Engr. and Surv., Eagle Lake, Tex. (*Jun., Feb. 3, 1903*)	Nov. 4, 1908
Smith, William Ernest. 730 West 3d St., Webb City, Mo	Dec. 1, 1908
Smith, William Stuart. Dist. Mgr., Warren Bros. Co., 49 West Ave., Rochester, N. Y	Jan. 8, 1902
Smith, Wilson Fitch. Div. Engr., Board of Water Supply of City of New York, Valhalla, N. Y. (*Jun., Jan. 3, 1895*)	May 1, 1901
Smoley, Constantine Kenneth. Prin. of School of Civ. Eng., International Correspondence Schools, Scranton, Pa	June 30, 1910
Snell, Harry Bronson. 315 Lafayette Ave., Brooklyn, N. Y	Dec. 5, 1906
Snell, Joseph Emmett. 247 North 6th St., Newark, N. J	April 5, 1910
Snell, Roy Martin. Engr., U. S. Reclamation Service, Helena, Mont	Sept. 6, 1910
Snyder, Charles Herman. City Engr., City Hall, Oswego, N. Y. (*Jun., Oct. 7, 1902*)	July 9, 1906
Snyder, Frederic Antes. Res. Mgr. and Secy., Cuban Eng. & Contr. Co., Arsenal 2, Havana, Cuba	June 1, 1904
Solomon, Gabriel Roberts. (Solomon-Norcross Co., Engrs.), 1622 Candler Bldg., Atlanta, Ga	Oct. 2, 1907

	Date of Membership
Soper, Ellis Clark. Pres., The Soper Co., 1110 Ford Bldg., Detroit, Mich.	Dec. 5, 1906
Soulé, Edward Lee. Structural Engr. with Jno. B. Leonard, 2532 Hillegas Ave., Berkeley, Cal. (*Jun., April 3, 1906*)	Jan. 4, 1910
Souther, Theodore Wheeler. West Point, N. Y.	Mar. 6, 1907
Southworth, Edward Augustus. Dept. of Public Works, Honolulu, Hawaii.	July 1, 1909
Sparrow, William Warburton Knox. Care, Waddell & Harrington, Orear-Leslie Bldg., Kansas City, Mo	Dec. 6, 1905
Spaulding, Frank Alger. 27 Pomeroy Ave., Pittsfield, Mass.	Jan. 31, 1911
Spear, Philip Hichborn. Asst. Engr., N. Y. C. & H. R. R. R.; Res., Hastings-on-Hudson, N. Y. (*Jun., Dec. 5, 1905*)	Feb. 5, 1908
Spearman, Charles. Cons. Hydr. and Irrig. Engr., Room 210, Boise City National Bank Bldg., Boise, Idaho	Oct. 5, 1909
Speicher, Pius Melanthon. Contr., Chandler, Okla.	Nov. 7, 1906
Spelman, John Rodgers. Cons. Engr., 125 East 23d St., New York City (Res., 60 Cedar St., Rockville Center, N. Y.)	Dec. 6, 1910
Spencer, Frank Norton. Chf. Engr., The A. Bentley & Sons Co., 37 North Huron, Toledo, Ohio	June 30, 1910
Spencer, Herbert. Cons. Engr., Standard Oil Co., Road Oil Dept., 26 Broadway, New York City. (*Jun., Feb. 2, 1904*)	Mar. 4, 1908
Spencer, Louis Bernard. Civ. and Min. Engr., Hawthorne, Nev. (*Jun., Oct. 31, 1899*)	Nov. 8, 1909
Spencer, Theodore Nelson. Asst. Engr., Bureau of Surveys, 4903 Cedar Ave., Philadelphia, Pa	Sept. 5, 1900
Spencer, Walter Tuttle. Div. Engr., N. Y., N. H. & H. R. R., Waterbury, Conn. (*Jun., May 2, 1893*)	Oct. 4, 1899
Spengler, Albert. Engr. and Supt. for H. S. Crocker, 2626 Holly St., Denver, Colo.	May 6, 1908
Spielman, John Godfrey. Illinois Steel Co., 1319 Wabansia Ave., Chicago (Res., 4128 N. Hermitage Ave., Ravenswood), Ill. (*Jun., Mar. 4, 1891*)	May 1, 1895
Spiker, William Clare. Cons. Engr., Forsyth Bldg., Atlanta, Ga.	June 5, 1907
Splitstone, Charles Harold. Chf. Draftsman, Erie R. R., 9 Girard Ave., East Orange, N. J. (*Jun., Sept. 5, 1905*)	Oct. 5, 1909
Stabler, Herman. Asst. Engr., Water Resources Branch, U. S. Geological Survey, Washington, D. C.	Nov. 1, 1910
Stansbury, Herbert Earl. Asst. Engr., E. P. & S. W. Sys., Tucumcori, N. Mex.	May 3, 1910
Stanton, Fred Caswell. Asst. Engr., Isthmian Canal Comm., Cristobal, Canal Zone, Panama	April 1, 1908
Stanton, Wilbor Dickens. Junior Engr., Isthmian Canal Comm., Las Cascadas, Canal Zone, Panama. (*Jun., Oct. 2, 1906*)	May 3, 1910
Starr, Herbert Harris. Asst. Engr., Erecting Dept., Am. Bridge Co. of N. Y., 1604 Pennsylvania Bldg., Philadelphia, Pa.	Oct. 2, 1907
Stearns, Edward Burnham. Asst. Div. Contr. Mgr., Am. Bridge Co. of N. Y., 30 Church St., New York City	June 1, 1898
Stearns, Fred Lincoln. Dist. Supt. of Street Cleaning, Scarsdale, N. Y. (*Assoc., June 3, 1902*)	Jan. 31, 1905
Stearns, Ralph Hamilton. Asst. Designing Engr., Board of Water Supply, 165 Broadway, New York City	Dec. 4, 1907
Steere, Anthony Enoch. Res. Engr., Barge Canal Office, Amsterdam, N. Y.	April 1, 1908
Steffens, William Frederick. Engr. of Structures, Boston & Albany R. R., South Station, Boston, Mass. (*Jun., April 3, 1900*)	Oct. 1, 1902
Stehle, Felix Charles. With Am. Bridge Co., Brooklyn Plant; Res., 421 South Columbus Ave., Mt. Vernon, N. Y.	June 3, 1903
Stengel, Carl Henry. Pres., Electrical Alloy Co., Morristown, N. J.	Oct. 3, 1906
Stenger, Ernest. Gen. Supt., Ray Con. Copper Co., 124 G St., Salt Lake City, Utah	June 5, 1895
Stepath, Charles Underhill. Olive Bridge, Ulster Co., N. Y. (*Jun., Feb. 3, 1903*)	July 10, 1907
Stephenson, Frank Henry. Asst. Engr., Chg. of Section, Board of Water Supply of New York, 127 Franklin St., New York City	Jan. 8, 1908
Stephenson, Stuart Augustus, Jr. Instr. in Math. and Graphics, Rutgers Coll. (Res., 266 Redmond St.), New Brunswick, N. J. (*Jun., Jan. 3, 1905*)	July 10, 1907
Stevens, Alexander. Supt. of Bldgs., N. Y. Fire Dept., 157 East 67th St., New York City	April 1, 1896
Stevens, Elihu William. With Constr. Service Co., 15 William St., New York City	April 6, 1909
Stevens, George M. 35 Sagamore Ave., Winthrop, Mass.	Nov. 6, 1907
Stevens, Harold Converse. Asst. Engr. Designer, New York Board of Water Supply, 165 Broadway, New York City	June 30, 1910
Stevens, Harold Lyell. 510 Hall Bldg., Kansas City, Mo.	April 6, 1909
Stevens, John Cyprian. Civ. and Hydr. Engr., Spalding Bldg., Portland, Ore.	April 1, 1908

	Date of Membership
Stevens, Perley Egbert. Asst. Engr., Bridge Dept., G. N. Ry., 1802 Hague Ave., St. Paul, Minn. (*Jun., April 6, 1897*)	April 2, 1902
Stevenson, Thomas Patton, Jr. Engr. and Contr. (Stevenson & Headman)) P. O. Box 1012, Rio de Janeiro, Brazil. (*Jun., April 4, 1905*)	Nov. 6, 1907
Stevenson, William Freeman. 605 West 178th St., New York City	Oct. 5, 1904
Stevenson, William Lawrie. Asst. Engr., Sewage Dis. Works, Bureau of Surveys, 412 City Hall, Philadelphia, Pa	Oct. 2, 1907
Stewart, Clinton Brown. Cons. Hydr. Engr., Wisconsin Bldg., Madison, Wis	Oct. 5, 1898
Stewart, John. Pres. and Treas., The Cranford Constr. Co., Gerke Bldg., Cincinnati, Ohio	Nov. 4, 1908
Stewart, John Truesdale. Chf. of the Div. of Agri. Eng., Univ. of Minnesota, University Farm, St. Paul, Minn	Sept. 6, 1905
Stewart, John Wellington. Care, W. B. Storey, Jr., Vice-Pres., A., T. & S. F. System, 1033 Ry. Exchange, Chicago, Ill	Jan. 2, 1907
Stewart, Spencer James. Div. Engr., Div. No. 1, N. Y. State Highway Comm., Poughkeepsie, N. Y	June 7, 1899
Stidham, Harrison. Secy. and Mgr., Washington Fertilizer Co., Hibbs Bldg., Washington, D. C	April 4, 1900
Stiles, Otho William. City Engr., 120 West Corwin St., Circleville, Ohio.	Dec. 6, 1910
Stockett, Alfred Walton. Mgr., The Simmer & Jack Proprietary Mines, Ltd., P. O. Box 192, Germiston, Transvaal, South Africa	Jan. 1, 1896
Stockman, Louis Richard. Engr., The Laramie-Poudre Reservoirs & Irrig. Co., 820 West Olive St., Fort Collins, Colo	July 9. 1906
Stockton, John. 4014 Spruce St., Philadelphia, Pa	Sept. 6, 1905
Stockton, Robert Summers. Engr. in Chg., Lower Yellowstone Irrig. Project, La Mesa, Glendive, Mont	April 6, 1909
Stoddard, Raymond French. Milford, Conn	Jan. 3, 1906
Stokes, Stanley Frederick. Govt. Engr., Mines Dept., Johannesburg, Transvaal, South Africa	Oct. 4, 1905
Stone, Willard Wilberforce. Asst. Engr., Board of Water Supply, City of New York, R. F. D. No. 3, Newburgh, N. Y	Feb. 7, 1906
Storer, Stacy Steward. Structural Engr., Care, Superv. Archt.'s Office, Treasury Dept., Washington, D. C	Nov. 4, 1908
Stout, Homer Harding. 114 North Kedzie Ave., Chicago, Ill	Oct. 7, 1908
Stowitts, George Putnam. Chf. Draftsman, N. Y. C. & H. R. R. R. Co., Room 1136, Grand Central Terminal (Res., 3168 Decatur Ave.), New York City	June 3, 1908
Strathmann, Edward Charles. Gen. Supt., Bedford Stone & Constr. Co., 814 Traction Bldg., Indianapolis, Ind	Nov. 8, 1909
Stratton, George Eber. Engr., U. S. Reclamation Service, Helena, Mont.	Jan. 8, 1902
Strawn, Thomas Corwin. Supt. for The Foundation Co., 355 West 55th St., New York City. (*Jun., Nov. 5, 1901*)	June 3, 1903
Strickler, Frederick Wineman. 448 Walnut St., Meadville, Pa	Dec. 6, 1910
Strickler, Thomas Johnson. Chf. Engr., Federal Structural Steel Co. (Res., 3428 Campbell St.), Kansas City, Mo	May 3, 1910
Strong, Archibald McClure. Min. and Civ. Engr., 418 Merchants Trust Bldg., Los Angeles, Cal	Jan. 8, 1908
Strong, James Boorman. Asst. Gen. Mgr., Ramapo Iron Works, Hillburn, N. Y	Oct. 5, 1904
Strong, William Edward Schenck. Mgr., Eng. Dept., Am. Radiator Co., 31 Nassau St., Room 1605, New York City	April 6, 1898
Stuart, James Lyall. Const. Engr., 341 Sixth Ave., Pittsburg, Pa. (*Jun., Oct. 4, 1898*)	Feb. 7, 1900
Stubblefield, Garfield. (Whistler & Stubblefield, Civ. and Hydr. Engrs.), Chamber of Commerce Bldg., Portland, Ore	Nov. 6, 1907
Sturgeon, George Blair. Engr. in Chg. of Constr. of Greater Univ. Roads and Bldgs., Constr. Office, Univ. of California, Berkeley, Cal	May 31, 1910
Suarez y Cordoves, Patricio Andres. Central "Esperanza," Calimete Cuba. (*Jun., April 6, 1909*)	Nov. 1, 1910
Sudriers, Victor Boureau. Agraciada 633, Montevideo, Uruguay	Oct. 3, 1906
Sullivan, John Francis. Asst. Engr., Office of Cons. Engr., Borough of Manhattan (Res., 610 West 139th St.), New York City	Jan. 4, 1910
Sullivan, Murray. Chf. Draftsman, Ore. Short Line R. R. Co., 606 Deseret News Bldg., Salt Lake City, Utah	Sept. 6, 1910
Sussex, James Wolfe. Archt. and Engr., Wenatchee, Wash. (*Jun., Oct. 6, 1903*)	Oct. 2, 1907
Suter, Russell. Asst. Civ. Engr., State Water Supply Comm. of New York, Albany, N. Y	Jan. 2, 1907
Sutton, Charles Wood. Chf. Engr., Hydrologic Comm. of "La Libertad," Trujillo, Peru. (*Jun., Dec. 1, 1903*)	Dec. 6, 1905
Swartwout, Roy Adolf. Vice-Pres. and Gen. Mgr., Western Bridge & Constr. Co., 340 Bee Bldg., Omaha, Nebr. (*Jun., May 2, 1905*)	July 1, 1909
Swaty, David Youngs. Asst. Engr., Penn. Lines W. of Pitts., 1116 Union Station, Pittsburg, Pa. (*Jun., Oct. 6, 1903*)	Oct. 3, 1906
Sweeney, Harry Clinton. Cons. Engr., 11 Broadway, New York City	July 1, 1909

	Date of Membership
SWEITZER, NELSON BOWMAN. U. S. Examiner of Surveys, Gen. Land Office, Washington, D. C. (*Jun., Feb. 28, 1893*)	Mar. 1, 1899
SWENDSEN, WARREN G. (Swendsen, Swendsen & Peirce), 27 Shaw Blk., Boise, Idaho	Dec. 6, 1910
SWICKARD, ANDREW. Res. Engr., South San Joaquin Irrig. Dist., 225 Adams St., San José, Cal	June 6, 1906
SWINDELLS, JOSEPH SPRINGER. Cons. Engr., 1090 East 18th St., Brooklyn, N. Y. (*Jun., Feb. 2, 1897*)	Mar. 2, 1904
SYKES, GEORGE. Bldg. Constr., 1123 Broadway, New York City. (*Jun., May 1, 1906*)	Dec. 4, 1907
SYKES, GEORGE WHITFIELD. Div. Engr., Port Boliver Iron Ore Ry., P. O. Box 322, Longview, Tex. (*Jun., April 30, 1895*)	Dec. 1, 1897
SYLVESTER, ALBERT HALE. Forest Supervisor, Wenatchee National Forest, Leavenworth, Wash	June 7, 1905
TAFT, JESSE RUSSELL. Tyngsborough, Mass. (*Jun., June 2, 1903*)	Sept. 6, 1905
TAGGART, RALPH CONE. World Bldg., New York City	Oct. 5, 1904
TAIT, HAROLD. Bureau of Sewers, Hackett Bldg., Long Island City, N. Y.	May 7, 1902
TAIT, JOHN GEORGE. Metuchen, N. J	May 6, 1896
TALBOT, EARLE. Chf. Engr., Contract 54, Catskill Aqueduct, 30 Mile Sq. Rd., Yonkers, N. Y. (*Jun., Nov. 1, 1904*)	Mar. 4, 1908
TALLMAN, LEROY. Care, Pittsburg Contr. Co., Elmsford, N. Y	Feb. 2, 1909
TALLMAN, PAUL BERTRAM. 118 N. Walnut St., East Orange, N. J. (*Jun., Oct. 3, 1905*)	Sept. 6, 1910
TARR, CHARLES WINTHROP. Asst. Engr., Dept., Water Supply, Gas and Electricity, New York City (Res., 10 Orange St., Brooklyn, N. Y.)	June 6, 1906
TARVER, THOMAS CARY, JR. City Engr., Houston, Tex	Sept. 6, 1910
TAUBENHEIM, ULRICH. Archangel, Russia	Feb. 1, 1905
TAYLOR, ALEXANDER JENIFER. City Engr., Wilmington, Del. (*Jun., Oct. 3, 1899*)	April 3, 1907
TAYLOR, EDWARD BALLINGER, JR. Div. Engr., Cincinnati & Muskingum Val. R. R. Co., Zanesville, Ohio	Sept. 6, 1910
TAYLOR, GRANVILLE LEWIS. Asst. Chf. Engr., McClintic-Marshall Constr. Co., Pittsburg, Pa	Feb. 2, 1909
TAYLOR, JACKSON, JR. Asst. Engr., U. S. Coal & Coke Co., Gary, W. Va.	Oct. 7, 1908
TAYLOR, OLIVER KIRK, JR. City Engr. and Surv., 767 East Maiden St., Washington, Pa	May 6, 1908
TAYLOR, ROBERT WILLIAM, JR. Mgr., Luzerne Eng. Co., 15 East Broad St., Hazleton, Pa	June 6, 1906
TAYLOR, WILLIAM PURVES. Engr. in Chg. of Philadelphia Municipal Testing Laboratories, 318 City Hall, Philadelphia, Pa. (*Jun., Oct. 7, 1902*).	May 4, 1909
TEBBETTS, GEORGE EDWARD. Bridge Engr., Kansas City Terminal Ry., 23d St. and Grand Ave., Kansas City, Mo	Jan. 4, 1910
TEIGEN, THOMAS WILLIAM ROSTAD. Office Engr., Mexico-Northwestern Ry., Pearson, Chihuahua, Mexico. (*Jun., Sept. 5, 1905*)	Dec. 1, 1908
TENNEY, WILLIAM FIELD. Asst. Engr., N. Y. C. & H. R. R. R., 327 Holcomb St., Watertown, N. Y	Nov. 1, 1910
TERRY, ALFRED HOWE. N. Y., N. H. & H. R. R., New Haven, Conn	June 6, 1906
TERRY, ARTHUR LINVILLE, JR. Secy. and Treas., Hungerford & Terry, 1414 Penna. Bldg., Philadelphia, Pa. (*Jun., Mar. 5, 1907*)	June 30, 1910
THANHEISER, CHARLES AUGUST. Asst. Supt., T. & N. O. R. R., Houston, Tex.	July 10, 1907
THAYER, HORACE RICHMOND. Asst. Prof. of Structural Design, Carnegie Technical Schools, 712 S. Linden Ave., Pittsburg, Pa	Mar. 7, 1906
THEBAN, JOHN GERARD. Engr. in Chg. of Dept. of Bridges, Borough of the Bronx, 428 East 133d St., New York City	Mar. 3, 1897
THEODORSON, WILLIAM ANTON. With Terminal Engr., C. & N. W. Ry., Jackson Boulevard and Franklin St., Chicago, Ill	Oct. 7, 1908
THOMA, JACOB. Bureau of Sewers, Hackett Bldg., Long Island City, N. Y.	Oct. 7, 1908
THOMAS, CHARLES DURA. Structural Designer, Interborough Rapid Transit Co., 32 Park Pl., New York City (Res., 547 Carlton Ave., Brooklyn, N. Y.)	Jan. 8, 1908
THOMAS, EDGAR BRANSON. Chf. Draftsman, Office of City Civ. Engr. (Res., 11417 Glenwood Ave., S. E.), Cleveland, Ohio	June 3, 1908
THOMAS, RALPH DANFORD. Asst. Engr., Minneapolis Mill Co., Minneapolis, Minn	May 6, 1908
THOMAS, WILLIAM EDWARD. Asst. Engr., L. I. R. R., Colonial Hall, Jamaica, N. Y	July 1, 1909
THOMAS, WILLIAM MICHAEL. Care, Young Constr. Co., 12th Floor, Union Trust Bldg., Los Angeles, Cal	Nov. 8, 1909
THOMES, EDWIN HOWARD. Asst. Engr., Bureau of Highways, Queens Borough, New York City; Res., 161 Willett St., Jamaica, N. Y	Dec. 6, 1899
THOMPSON, CLARENCE HARD. Structural Engr., The Solvay Process Co., 209½ Sabine St., Syracuse, N. Y	Sept. 7, 1904
THOMPSON, CLARK WALLACE. Vice-Pres., Wind River Lumber Co., Cascade Locks, Ore. (*Jun., Mar. 5, 1890*)	July 3, 1895

	Date of Membership
Thompson, Mackey James. 514 Pioneer Press Bldg., St. Paul, Minn.	Oct. 7, 1903
Thomson, Alexander, Jr. Div. Engr., Board of Water Supply, Walden, Orange Co., N. Y. *(Jun., Dec. 4, 1900)*	Feb. 3, 1904
Thomson, Samuel Forsythe. Asst. Engr., Board of Water Supply, New York City, New Paltz, Ulster Co., N. Y.	Jan. 3, 1906
Thorn, Columbus William. Asst. Engr., Constr., P. R. R., Camden Terminal, Camden, N. J.	July 9, 1906
Thrane, Martin Mathias. Engr., Bldg. Dept., Gen. Elec. Co., Pittsfield, Mass.	Jan. 8, 1908
Throop, Augustus Thompson. Gen. Mgr., Elec. Dept., Utica Gas & Elec. Co., 222 Genesee St., Utica, N. Y. *(Jun., Oct. 3, 1893)*	Mar. 3, 1897
Throop, George Huntington. Care, J. G. White & Co., 43 Exchange Pl., New York City	May 1, 1907
Thurber, Clinton Draper. Civ. Engr., U. S. N., Naval Training Station, Great Lakes, North Chicago, Ill.	Oct. 4, 1905
Thuringer, Charles. 430 State St., Madison, Wis.	Mar. 4, 1908
Thurston, Eugene True, Jr. Designing and Contr. Engr., 57 Post St., San Francisco, Cal.	Mar. 6, 1907
Tibbetts, Frank Leslie. Asst. Engr., East Boston Co., 19 Congress St., Boston, Mass.	Jan. 4, 1910
Tibbetts, Frederick Horace. Structural and Hydr. Engr.; Asst. Prof., Civ. Eng., Univ. of California, Berkeley, Cal. *(Jun., May 1, 1906)*	April 6, 1909
Tidd, Arthur Warren. Section Engr., New York City Board of Water Supply, Hill View Div., Yonkers (Res., White Plains), N. Y.	June 3, 1903
Tiffany, Nelson Otis, Jr. Engr. and Contr. (Tiffany & Gail), 13 Erie Co. Bank Bldg., Buffalo, N. Y.	Jan. 2, 1907
Tilden, Charles Joseph. Junior Prof. of Civ. Eng., Univ. of Michigan, 1619 Cambridge Rd., Ann Arbor, Mich. *(Jun., May 31, 1898)*	Feb. 5, 1902
Tillinghast, Frederick Howard. Orland, Glenn Co., Cal.	May 1, 1907
Tilmont, Paul Alphonse Gaillard. Track and Ballast Engr., N. P. Ry., 808 G St., Centralia, Wash.	July 1, 1909
Tilt, Garret Edward. Chf. Engr., Structural Dept., Care, John Monks & Sons, 82 Beaver St., New York City	June 1, 1909
Tinkham, Ralph Russell. Engr. with Trussed Concrete Steel Co., Trussed Concrete Bldg., Detroit, Mich. *(Jun., Oct. 3, 1905)*	Sept. 6, 1910
Titsworth, Ralph Bentley. 452 W. 5th St., Plainfield, N. J.	Dec. 1, 1908
Toltz, Max. Gen. Mgr., Manistee & Grand Rapids R. R., 702 Capitol Bank Bldg., St. Paul, Minn.	Sept. 7, 1892
Tombo, Carl. 150 East 36th St., New York City. *(Jun., Feb. 3, 1903)*	Jan. 4, 1910
Tompkins, Charles Hook. 149 Rhode Island Ave., N. W., Washington, D. C.	Dec. 6, 1910
Tooker, Francis Westervelt. Landscape Archt. and Engr. (Hinchman, Pilat & Tooker), 52 Broadway, New York City	Dec. 6, 1905
Toops, George Noble. Asst. Engr. on Constr., Ore. Short Line R. R. Co., Box 543, Pocatello, Idaho. *(Jun. April 5, 1910)*	Oct. 4, 1910
Torre, Alberto de la. Res. Engr., The Colombian National Ry. Co., Ltd. (Ferrocarril de Girardot), Girardot, Colombia	Oct. 3, 1906
Torrey, James Eaton. 369 East 30th St., Paterson, N. J.	May 3, 1905
Tower, James Wallace. Engr. for H. S. Ferguson, Room 1303, Fifth Ave. Bldg., New York City	Oct. 2, 1901
Tracy, Louis Downer. Civ. and Min. Engr., 245 Fourth Ave. (Res., 108 Lincoln Ave., Edgewood Park, Allegheny Co.), Pittsburg, Pa.	Oct. 3, 1906
Tratman, Edward Ernest Russell. 1636 Monadnock Blk., Chicago, Ill. *(Jun., April 7, 1886)*	July 1, 1891
Travell, Warren Bertram. 165 Broadway, New York City (Res., 816 Third Pl., Plainfield, N. J.). *(Jun., April 30, 1895)*	Mar. 5, 1902
Treadway, Howard Platt. Vice-Pres. and Treas., Kansas City Bridge Co., 45 Water-Works Bldg., Kansas City, Mo.	May 6, 1903
Treadwell, William Adams. Asst. Engr., N. Y. State Dept. of Highways, 187 Elk St., Albany, N. Y. *(Jun., April 4, 1905)*	Feb. 1, 1910
Trott, David Crooker. Supt. of Constr. with Superv. Archt., U. S. Treasury Dept., Appleton, Wis.	Sept. 6, 1910
Trow, Frank Hamant. Chf. Engr. for MacArthur Bros. Co. and Winston & Co., Contrs., Brown Station, N. Y.	Feb. 7, 1906
True, Albert Otis. Asst. Engr., New York State Dept. of Health, Albany, N. Y. *(Jun., Feb. 5, 1907)*	May 31, 1910
Tucker, Herman Franklin. Designing Engr., Isthmian Canal Comm., Culebra, Canal Zone, Panama	Dec. 7, 1904
Tudbury, Warren Chamberlain. Asst. Engr., N. Y. C. & H. R. R. R. Co., 33 Main St., Utica, N. Y.	June 1, 1909
Tudor, Clinton Gambrill. U. S. Surv.-Gen.'s Office, P. O. Box 862, Reno, Nev.	May 1, 1907
Tull, Richard William. Asst. Engr., Eastern Steel Co., 71 Broadway, New York City	May 3, 1905
Tunstall, Whitmell Pugh. Board of Superv. Engrs., Chicago Traction, 181 La Salle St., Chicago, Ill. *(Jun., Oct. 6, 1903)*	Nov. 4, 1908

	Date of Membership
TURLEY, OMNER JAY. Box 151, Aztec, N. Mex.	April 6, 1909
TURNEAURE, FREDERICK EUGENE. Dean, Coll. of Eng., Univ. of Wisconsin, Madison, Wis. (*Assoc., Aug. 31, 1897*)	June 4, 1902
TURNER, AUGUSTUS MIESSE. Care, C., C., C. & St. L. Ry., 315 East 5th St., Mt. Carmel, Ill.	Dec. 1, 1908
TURNER, FRANKLIN PIERCE. Asst. Engr., N. & W. Ry. Co., Chillicothe, Ohio (Res., Christiansburg, Va.)	May 6, 1908
TURNER, GEORGE DALLAS BAIRD. Care, South Cambria Collieries, Pentyrch, near Cardiff, Wales	Nov. 2, 1898
TURNER, HENRY CHANDLEE. Pres., Turner Constr. Co., 11 Broadway, New York City	April 4, 1906
TURNER, NATHANIEL PARKER. Chf. Engr., Cuba R. R. Co., Hotel Camagüey, Camagüey, Cuba	Dec. 1, 1908
TURNER, WILLIS TUBBS. St. Petersburg, Fla.	Dec. 7, 1904
TURNEY, OMAR ASA. City Engr., Phœnix, Ariz.	May 6, 1908
TWIGGS, JOHN DAVID, JR. Supt., Canal and Water-Works, Augusta, Ga.	Nov. 1, 1905
TYLER, ROY DEXTER. Greeley, Colo.	Mar. 6, 1907
TYRRELL, WARREN AYRES. Secy. and Treas., Markmann-Tyrrell Eng. Co., 620 Chestnut St., St. Louis, Mo. (*Jun., Oct. 2, 1900*)	Oct. 1, 1902
ULRICH, DANIEL. Katonah, Westchester Co., N. Y.	Sept. 1, 1897
ULRICH, EDMUND BOYD. City Engr. and Chf. Commr., Highways and Sewers, Reading, Pa.	April 6, 1909
UNDERHILL, GRANDISON GRIDLEY. Asst. Engr., N. Y. State Barge Canal, Albany, N. Y.	June 5, 1907
UNDERWOOD, HOWARD WARREN. (Field, Barker & Underwood, Inc., Engrs. and Contrs.), 718 Arcade Bldg., Philadelphia, Pa. (*Jun., Dec. 3, 1901*)	April 3, 1907
UNGER, ERIK BIRGER LUND. P. O. Box 1086, Saskatoon, Sask., Canada	Nov. 8, 1909
UNGRICH, MARTIN JACOB. Asst. Engr., Board of Water Supply, 127 Franklin St. (Res., 505 West 142d St.), New York City	Mar. 1, 1910
UPHAM, RICHARD DANA. 11 Broadway, New York City. (*Assoc., Oct. 6, 1896*)	April 3, 1901
UPSON, MAXWELL MAYHEW. Secy. and Gen. Mgr., Raymond Concrete Pile Co., 140 Cedar St., New York City	May 6, 1908
URQUHART, GEORGE COPELAND. Real Estate Agt., Penn. Lines W. of Pitts., 1104 Union Station Bldg., Pittsburg, Pa.	May 6, 1891
VAIL, JOHN JERVIS. Constr. Dept., P. R. R. (Res., 59 Hazlewood Ave.), Rahway, N. J.	Jan. 4, 1905
VALLE ZENO, CARLOS DEL. (Del Valle Zeno Bros., Contr. Engrs.), San Juan, Porto Rico	April 1, 1908
VALLELY, WILLIAM PATRICK. 335 West 35th St., New York City	Jan. 3, 1911
VAN BUSKIRK, CLARENCE RANDALL. Civ. Engr., Surv. and Archt., 180 Montague St., Brooklyn, N. Y.	Feb. 3, 1897
VANCE, ALEXANDER MILTON. Pierce City, Mo.	Nov. 7, 1906
VAN ETTEN, LAWRENCE EDWARD. New Rochelle, N. Y.	Dec. 6, 1899
VAN LIEW, JOHN EDGAR. Contr. Engr., Des Moines Bridge & Iron Works (Res., 1306 E. Grand Ave.), Des Moines, Iowa	July 1, 1908
VAN LOAN, SETH MORTON. First Asst. to Chf., Bureau of Water, Room 790, City Hall, Philadelphia, Pa. (*Jun., Dec. 28, 1900*)	Oct. 7, 1903
VANNEMAN, CHARLES REEVE. Steam R. R. Insp., Public Service Comm., Second Dist. (Res., 436 Hudson Ave.), Albany, N. Y.	June 3, 1908
VAN NESS, HOWARD EDWARD. Asst. Engr., C. R. R. Co. of N. J., Little Falls, N. J.	Dec. 4, 1907
VAN ORNUM, SAMUEL JUDSON. City Engr., Pasadena, Cal.	Dec. 4, 1907
VAN PELT, SUTTON. Gen. Mgr. of Constr., Am. Asphaltum & Rubber Co., 601 Harvester Bldg., Chicago, Ill. (*Jun., Mar. 6, 1900*)	Dec. 2, 1903
VAN SUETENDAEL, ACHILLE OCTAVE. Structural Engr., State Archt.'s Office, Albany, N. Y. (*Jun., Jan. 3, 1905*)	June 3, 1908
VEDELER, GERDT HENRIK. Medlem av styret for det industrielle retsvern, Kronprinsens Gt. 4, Christiania, Norway	June 7, 1893
VEHRENKAMP, HENRY WILLIAM. Chf. Engr., The Ferro Concrete Constr. Co., 3113 Murdock Ave., Cincinnati, Ohio	June 5, 1907
VERNON, STEPHEN BARKER. Asst. Engr., Syracuse Intercepting Sewer Board, City Hall, Syracuse, N. Y.	Jan. 4, 1910
VERVEER, EMANUEL LOUIS. Contr. Engr., Alfred E. Norton Co., 18 West 27th St., New York City	June 3, 1903
VICKERS, THOMAS MCELDERRY. Mgr., Waldorf Mfg. Co., Auburn, N. Y.	Mar. 2, 1898
VIER, HENRY. Engr. of Resurveys, N. Y. C. & H. R. R. R. Co., Room 1120, Grand Central Station, New York City	Feb. 7, 1900
VILLALON, JOSÉ RAMON. Calle de Cuba No. 37, Havana, Cuba. (*Jun., July 4, 1888*)	Nov. 6, 1895
VINTON, THOMAS MACINTIRE. Pres., Tucker & Vinton, Terminal Bldg., 41st St. and Park Ave., New York City	Feb. 3, 1904

	Date of Membership
Vliegenthart, Johannes Cornelis. Engr., Hai-ho River Conservancy, Tientsin, North China	June 5, 1907
Vogt, John Henry Leon. Secy. and Treas., Associated Eng. Co., 112 W. Jefferson St., Louisville, Ky	April 6, 1909
von Unwerth, Hans. Cons. Engr., 722 Dwight Bldg., Kansas City, Mo.	May 6, 1903
Voorhees, Paul. Asst. Engr., P. & R. Ry. Co., Room 508, Telegraph Bldg., Harrisburg, Pa	Feb. 3, 1892
Voynow, Constantine Borisson. Asst. Engr.-of-Way, Phila. Rap. Trans. Co., 820 Dauphin St., Philadelphia, Pa	Sept. 7, 1904
Vrooman, Morrell. City Engr., Gloversville, N. Y	May 7, 1902
Wachter, Charles Lucas. Engr., Lidgerwood Mfg. Co., 96 Liberty St., New York City. (*Jun., June 3, 1902*)	Oct. 5, 1904
Wada, Yoshichika. Shimamura, Sabagun, Gunbaken, Japan. (*Jun., Sept. 7, 1887*)	Oct. 2, 1895
Waddell, Frederick Creelman. Structural Engr. with Hudson Structural Steel Co., 136th St. and Southern Boulevard, New York City	Oct. 4, 1905
Wade, George Willis. Asst. Engr., S. P. Co., 3d and Townsend Sts., San Francisco, Cal	Nov. 1, 1910
Wagner, Harry Edward. Res. Engr., D., L. & W. R. R., Andover, N. J.	Nov. 6, 1907
Wait, Owen Adelbert. Asst. Engr., Southern Cal. Edison Co., 329 San Fernando Bldg., Los Angeles, Cal	Dec. 6, 1905
Waite, Donald Cramer. Asst. Engr., Interborough Rapid Transit Co., 165 Broadway (Res., 615 West 144th St.), New York City. (*Jun., Jan. 3, 1905*)	April 5, 1910
Waldron, Albert Edwin. Capt., Corps of Engrs., U. S. A., U. S. Engr. Office, Federal Bldg., Dallas, Tex	July 1, 1909
Walker, Albert Willard. Asst. Engr., U. S. Reclamation Service, Orman, S. Dak	May 3, 1910
Walker, Edward Lloyd. Care, Dept. of Water Supply, Gas and Electricity, Room 2332, Park Row Bldg., New York City. (*Jun., Feb. 3, 1903*)	Oct. 3, 1906
Walker, Edward Mansfield. Mich. Central R. R. Co., 69 Rosedale Court, Detroit, Mich	Nov. 8, 1909
Walker, Joseph Jeanes. Dobbs Ferry, N. Y	Nov. 5, 1902
Wallace, William McGehee. 2028 F St., N. W., Washington, D. C. (*Jun., April 3, 1894*)	Nov. 6, 1901
Walling, Victor Roy. Supt., Cananea Consolidated Copper Co.'s Ry., Cananea, Sonora, Mexico	June 6, 1906
Walter, George Shirley. Care Hotchkiss Contr. Co., 1210 Manhattan Bldg., Chicago, Ill	Jan. 5, 1909
Walters, Henry Radclyffe St. Arvans. Supt. of Bridge Shop, Bethlehem Steel Co. (Res., 228 Wall St.). Bethlehem, Pa. (*Jun., Oct. 6, 1903*)	April 5, 1905
Walther, Edward. 1421 Humboldt Boulevard, Chicago, Ill	May 1, 1895
Waltman, William DeWitt. Res. Engr., The Costilla Estates Development Co., San Luis, Colo	Dec. 1, 1908
Ward, Charles Clarence. P. O. Box 507, Wenatchee, Wash	July 10, 1907
Ward, Walter. Care, U. S. Reclamation Service, Boise, Idaho	May 3, 1910
Ware, John. Asst. Engr., Cambridge Main St. Subway, Boston Elev. Ry., 18 Ash St., Cambridge, Mass	July 9, 1906
Waring, Charles Thomas. Asst. Engr., Cape Cod Canal, Buzzards Bay, Mass	Mar. 1, 1910
Warner, John Elliott. County Surv., Scott County, Benton, Mo	Sept. 6, 1910
Warren, Herbert Anson. Contr. Mgr., Am. Bridge Co. of N. Y., 30 Church St., New York City	Sept. 5, 1906
Washington, William de Hertburne. 267 Fifth Ave., New York City	Oct. 5, 1892
Wasser, Thomas James. 1 Montgomery St., Jersey City, N. J	April 3, 1907
Wassner, Michael. Chf. Engr., Indiana Northwestern Traction Co., 222 La Salle St., Chicago, Ill	June 5, 1907
Watanabe, Eitaro. Imperial Taiwan Rys., Takow, Formosa, Japan	April 5, 1905
Waterbury, Leslie Abram. Prof. of Civ. Eng., Univ. of Arizona, Tucson, Ariz. (*Assoc., Nov. 7, 1906*)	June 30, 1910
Watkins, Guy Anderson. (Dickinson & Watkins, Engrs.), State Bank Bldg., Little Rock, Ark. (*Jun., Jan. 3, 1907*)	Nov. 8, 1909
Watson, Walter. Salem, Va	April 5, 1893
Waugh, William Hammond. Div. Engr., Bureau of Public Works, Manila, Philippine Islands. (*Jun., Oct. 1, 1901*)	June 5, 1907
Webber, Charles Perkins. Ingeniero Principal de Construccion, Ferro Carriles Nationales de Mexico, Apartado 11, Tierra Blanca, Ver., Mexico	Oct. 7, 1908
Webber, Roy Irvin. Associate Prof., Structural Eng., The Pennsylvania State Coll., State College, Pa	April 1, 1908
Wedgeworth, Donald Clark. Res. Engr., Barge Canal Office, Syracuse, N. Y	April 1, 1908
Weidel, Joseph. Asst. Engr., A., T. & S. F. Ry. System, 704 Home St., Topeka, Kans	July 10, 1907

	Date of Membership
Weidner, Carl Robert. Instr. in Hydr. Eng., Univ. of Wisconsin, 422 North Henry St., Madison, Wis. (*Jun., Feb. 28, 1905*)	April 5, 1910
Weiland, Adelbert Alonzo. Chf. Engr. for The Arkansas Val. Ditch Assoc., 410 Central Blk., Pueblo, Colo	April 6, 1909
Weinstock, Harry Herschel. Auditor, New York Times Co., 60 West 119th St., New York City	June 30, 1910
Weiss, Andrew. Project Engr., U. S. Reclamation Service, Mitchell, Nebr.	Jan. 8, 1908
Welborn, Marvin Curtis. Engr., Water, Light and Power Dept., City of Austin, Austin, Tex	Nov. 8, 1909
Weller, Francis Repetti. Civ. and Hydr. Engr., Hibbs Bldg., Washington, D. C. (*Jun., Feb. 5, 1901*)	Nov. 1, 1905
Welles, Earle Hubbel. Address unknown	Feb. 7, 1906
Welton, Benjamin Franklin. Examining Engr., Commrs. of Accounts, 280 Broadway, New York City (Res., 1 Wiener Pl., Tompkinsville, N. Y.). (*Jun., April 6, 1897*)	Nov. 1, 1905
Wemlinger, Julius Ralph. Pres., Wemlinger Steel Piling Co., 11 Broadway, New York City	Nov. 8, 1909
Wenige, Arthur Emil. Asst. Engr., Dept. of Water Supply, Borough of Brooklyn, Brooklyn, N. Y. (*Jun., May 6, 1902*)	Oct. 7, 1908
Wentworth, Charles Austin. Cons. Engr., Pennsylvania Bldg., Philaphia, Pa	Oct. 7, 1903
Wescott, Jay Varnum. Q. & C. Co., Peoples Gas Bldg., Chicago, Ill.	Nov. 30, 1909
West, Oscar James. Res. Engr., The Phœnix Bridge Co., 453 The Rookery, Chicago, Ill	May 4, 1904
Weston, Robert Spurr. San. Engr., 14 Beacon St., Boston, Mass.	Feb. 5, 1902
Westover, Henry Christopher. Cons. Engr., Rollins & Westover, 534 Beals Bldg., Kansas City, Mo. (*Jun., Nov. 1, 1904*)	April 5, 1910
Wheat, George Neville. Structural Engr. with F. L. Dormant, Cons. City Engr., Houston, Tex	Jan. 4, 1910
Wheaton, Walter Robert. Supt. of Timber Dept., San Joaquin Light & Power Co., Fresno, Cal	Feb. 2, 1909
Wheeler, Arthur Chambers. U. S. Engr. Office, Honolulu, Hawaii	Oct. 7, 1908
Wheeler, Ralph Norman. Div. Engr., New York Board of Water Supply, 236 Main St., Poughkeepsie, N. Y	Jan. 7, 1903
Whipple, Robert Lee. With U. S. Govt. at Naval Magazine, Hingham, Mass	Sept. 6, 1910
Whiskeman, James Peter. Cons. Engr., 39 West 38th St., New York City (Res., 139 Barry Ave., Mamaroneck, N. Y.). (*Jun., Jan. 31, 1899*)	Nov. 7, 1900
Whitaker, Ralph Wallace. Prin. Asst. Engr., Vera Cruz Terminal Co., Ltd., Vera Cruz, Mexico	April 5, 1910
Whitaker, William Franklin. Supt. of Canals, Kern County Canal & Water Co., 2620 Nineteenth St., Bakersfield, Cal. (*Jun., April 4, 1905*).	Sept. 6, 1910
Whitbeck, Lee Field. Div. Engr., National Rys. of Mexico, Estacion Pénjamo, Guanajuato, Mexico. (*Jun., Dec. 6, 1904*)	Nov. 1, 1910
White, Arthur Burr. (Bixby & White, Civ and Hydr. Engrs.), 502 Mason Bldg., Los Angeles, Cal	Nov. 7, 1906
White, Byron Ellsworth. Engr., Utica Gas & Electricity Co., 222 Genesee St. (Res., 15 Steuben St.), Utica, N. Y. (*Jun., Oct. 2, 1906*)	July 1, 1908
White, David Miller. Cons. Engr.; Chf. Engr., Red Bluff Irrig. Co., P. O. Box 278, Midland, Tex	Nov. 8, 1909
White, Frank George. Asst. Engr., Office of City Engr., Hewes Bldg., San Francisco, Cal. (*Jun., Dec. 3, 1901*)	Dec. 7, 1904
White, Gilbert Case. Cons. Municipal and Hydr. Engr., Durham, N. C.	April 5, 1905
White, Lazarus. Div. Engr., Board of Water Supply, City of New York, High Falls, N. Y. (*Jun., May 1, 1900*)	Feb. 4, 1903
Whitford, Noble Earl. Res. Engr., Dept. of State Engr., State Hall, Albany, N. Y	Feb. 1, 1905
Whiting, George William Carlyle. Vice-Pres. and Gen. Mgr., The Whiting Middleton Constr. Co., Sexton Bldg., Baltimore, Md. (*Jun., Sept. 5, 1905*)	Nov. 8, 1909
Whitman, Nathan Davis. Engr., Reinforced Concrete Pipe Co., 525 Central Bldg., Los Angeles, Cal	Dec. 5, 1906
Whitman, Ralph. Asst. Civ. Engr., U. S. N., Bureau of Yards and Docks, Navy Dept., Washington, D. C	Nov. 6, 1907
Whitsit, Lyle Antrim. Prin. Asst. Engr., Long Sault Development Co. and St. Lawrence River Power Co., Massena, N. Y. (*Jun., Oct. 31, 1905*)	Sept. 6, 1910
Whitson, Abraham Underhill. Asst. Engr., Board of Water Supply, Cold Spring, N. Y. (*Jun., Jan. 7, 1902*)	Dec. 5, 1906
Whitted, Levi Romulus. Supt. of Constr., U. S. Public Bldgs., Treasury Dept., Burlington, N. C. (*Jun., Mar. 6, 1900*)	July 9, 1906
Wickersham, John Hough. Lancaster, Pa. (*Jun., May 6, 1902*)	April 6, 1909
Wickes, Joseph Lee. Commr. of Street Cleaning, City Hall, Baltimore, Md.	Mar. 2, 1904
Widdicombe, Robert Alexander. Care, W. A. Pope Co., 5552 Lakewood Ave., Chicago, Ill. (*Jun., April 2, 1901*)	Dec. 6, 1905

	Date of Membership
Wiggin, Ernest Woodbury. Engr., Central New England Ry. Co., Hartford (Res., 48 Third St., New Haven), Conn. (*Jun., May 5, 1896*)	May 7, 1902
Wiggin, Thomas Hollis. Senior Designing Engr., Board of Water Supply, 165 Broadway, New York City	April 2, 1902
Wiggins, Ralph Raymond. Asst. Engr., Office of Chairman and Chf. Engr., Isthmian Canal Comm., Culebra, Canal Zone, Panama	Oct. 5, 1909
Wiggins, William D. Engr., M. of W., Pittsburg Div., Pitts., Cin., Chic. & St. L. Ry., 1013 Penn Ave., Pittsburg, Pa	Oct. 2, 1901
Wilcock, Frederick. Asst. Engr., Public Service Comm., New York City, 23 Flatbush Ave., Brooklyn, N. Y. (*Jun., Jan. 7, 1902; Assoc., Oct. 6, 1903*)	Jan. 4, 1910
Wilcox, Clark Luzerne. Treas., The Pitt Constr. Co., Inc., 821 Fulton Bldg., Pittsburg, Pa. (*Jun., Dec. 3, 1901*)	Mar. 1, 1910
Wilcox, Frank Leslie. Hydr. and San. Engr., Victoria Bldg., St. Louis, Mo. (*Jun., Sept. 6, 1904*)	Feb. 1, 1910
Wilcox, Fred Elmer. 956 Orange Grove Boulevard, Pasadena, Cal	April 1, 1896
Wild, Herbert Joseph. Supt. of Exploratory Work, St. Croix River, Box 135, Grantsburg, Wis. (*Jun., March 31, 1903*)	April 6, 1904
Wildes, Waldo Gilman. Res. Engr., State Engr.'s Office, State Hall, Albany, N. Y. (*Jun., Feb. 3, 1903*)	Jan. 2, 1907
Wilgus, Herbert Sedgwick. Engr., M. of W., P., S. & N. R. R., Angelica, N. Y. (*Jun., Oct. 1, 1901; Assoc., Nov. 3, 1903*)	Nov. 1, 1904
Wilhelm, George. Chf. Engr., Peoples Water Co., Oakland, Cal	Oct. 4, 1910
Wilhelm, Jerome Frederick. Care, Missouri Val. Bridge & Iron Co., Sacramento, Cal. (*Jun., Jan. 2, 1900*)	Mar. 7, 1906
Willard, Norman Rand. Ambursen Hydr. Constr. Co., 88 Pearl St., Boston, Mass	June 1, 1909
Williams, Enrique Ruiz. Locating Engr., Cuban Central Rys. Co., Ltd., Sagua la Grande, Cuba	Dec. 6, 1910
Williams, Harold S. Caldwell, Idaho. (*Jun., Sept. 1, 1908*)	April 5, 1910
Williams, Howard Shay. Washington Apartments, Cleveland, Ohio. (*Jun., Dec. 1, 1903*)	June 5, 1907
Williams, Jacob Paul Jones. Asst. Prof. of Civ. Eng., Columbia Univ., New York City	July 1, 1909
Williams, LeRoy Duncan. County Surv. and Highway Engr., Macon County, Macon, Mo. (*Jun., Feb. 5, 1907*)	May 31, 1910
Williams, Lester Dennison. Pres., Hirschberg-Williams-Washburn Co., Civ. Engrs., Milwaukee, Wis	Nov. 8, 1909
Williams, Maurice. Barge Canal Office, Frankfort, N. Y	Jan. 31, 1911
Williams, Parley Lycurgus, Jr. Care, Daly West Min. Co., 163 Main St., Salt Lake City, Utah	Sept. 7, 1904
Williams, Roger Butler, Jr. 32 Nassau St., New York City. (*Jun., Oct. 1, 1901*)	Mar. 7, 1906
Williams, Samuel Walter. 1035 Security Bldg., Los Angeles, Cal	Feb. 7, 1906
Williams, Walter Scott. Asst. Prof., Civ. Eng., Univ. of Missouri, 818 Virginia Ave., Columbia, Mo	April 6, 1904
Williamson, Charles Sumner. Contr. Engr. for Heyl & Patterson, Inc., Pittsburg, Pa	Feb. 7, 1906
Williamson, Harry. Sectional Engr., Buenos Aires & Pacific Ry. Co., Ltd., Bahia Blanca, Argentine Republic	Oct. 4, 1910
Willis, Harry Parsons. Div. Engr., Dept. of Highways, Albany, N. Y.	Mar. 6, 1907
Wills, Arthur John. 1021 Simpson St., New York City	May 7, 1902
Wilson, Harry Percival. 11 Shirley St., Worcester, Mass. (*Jun., Nov. 5, 1907*)	Oct. 5, 1909
Wilson, James Bean. Res. Bridge Engr., Ky. & Ind. Terminal R. R. Co., 29th and High Sts., Louisville, Ky	May 2, 1906
Wilson, Phillip Lindsley. Div. Engr., F. E. C. Ry., Key West Extension, Islamorada, Fla	July 1, 1908
Wilson, Thad Loren. Asst. Engr., Sewer Div., Rapid Transit Comm., 1532 Bedford Ave., Brooklyn, N. Y	July 10, 1907
Wilson, Thomas William. 548 Franklin St., Buffalo, N. Y	April 4, 1900
Wilson, Wilbur Thomas. 520 West 122d St., New York City	July 1, 1908
Wilson, William Renfrew. Imperial Rys. of North China, Tientsin, North China	Jan. 4, 1910
Winchester, Philip Harold. Div. Engr., N. Y. C. & H. R. R. R., Watertown, N. Y. (*Jun., Jan. 7, 1902*)	Feb. 5, 1908
Winfree, Peyton Brown. Asst. Mgr., The Glamorgan Pipe & Foundry Co., Lynchburg, Va. (*Jun., Oct. 2, 1894*)	May 3, 1898
Wing, Frederick Kelly. Cons. Engr., 910 White Bldg., Buffalo, N. Y. (*Jun., May 31, 1892*)	Nov. 1, 1899
Winn, Walter Scott. Secy. and Mgr., The North Alabama Constr. Co., 1366 Humboldt St., Denver, Colo	Oct. 6, 1897
Winslow, Arthur Ellsworth. Prof., Civ. Eng., Norwich Univ., Northfield, Vt	June 6, 1906
Winslow, Carlile Patterson. Engr. in Wood Preservation, Forest Products Laboratory, Madison, Wis	Mar. 1, 1910

ASSOCIATE MEMBERS W-Z

	Date of Membership
Winterhalter, Leo P. 70 N. Prospect St., Akron, Ohio	July 1, 1909
Wise, James Hugh. Civ. and Hydr. Engr. with F. G. Baum & Co., 1404 Chronicle Bldg., San Francisco, Cal	Feb. 6, 1907
Witham, Myron Ellis. Cons. Engr. (Bull & Witham), 411 Commonwealth Bldg., Denver, Colo	Aug. 31, 1909
Witherell, Frederick Whitefield. (Geo. S. Baton & Co., Civ. and Min. Engrs.), Keystone Bldg., Pittsburg, Pa. (*Jun., Oct. 6, 1903*)	July 9, 1906
Wolcott, Christopher Stanton. Engr. for W. H. Gahagan, Section 4, D., L. & W. Cut-Off, Newton, N. J	June 5, 1907
Wolff, Hans Hermann. 403 White Bldg., Seattle, Wash	Jan. 8, 1908
Wonson, Samuel Lamson. Gen. Bridge Insp., Mo. Pac. Ry., 309 Title Guaranty Bldg., St. Louis, Mo	Oct. 5, 1909
Wood, George. 122 West 167th St., High Bridge, New York City	June 5, 1907
Wood, George Roy. Pres., Wood-Randolph Co., Cons. Elec. Engrs., Oliver Bldg., Pittsburg, Pa	April 4, 1906
Wood, Robert Walter. Asst. Engr. in Chg. of Port Richmond Div., Borough of Richmond, New York City, 913 Post Ave., Port Richmond, N. Y. (*Jun., April 30, 1907*)	Nov. 8, 1909
Wood, Winthrop Barrett. Civ. and Mech. Engr. for The Wanskuck Co., 725 Branch Ave., Providence, R. I	April 6, 1904
Woodard, Wilkie. 317 Lissner Bldg., Los Angeles, Cal	May 4, 1904
Woodcock, Henry Wright. Civ. Engr. and Surv., 261 Fifty-second St., Brooklyn, N. Y. (*Jun., Dec. 1, 1903*)	Dec. 4, 1907
Woodle, Allan Sheldon, Jr. Baldwin Locomotive Works, Philadelphia, Pa.	July 9, 1906
Woods, Andrew Alfred. Res. Engr., Alabama & Vicksburg Ry. and Vicksburg, Shreveport & Pacific Ry., Vicksburg, Miss	May 4, 1904
Woodward, Edwin Carlton. Paving Engr., 1400 Cooper St., Fort Worth, Tex	Oct. 4, 1905
Work, Joe Young. Care, Elks Club, Denver, Colo	May 3, 1910
Worley, John Stephen. 206 Reliance Bldg., Kansas City, Mo	June 5, 1907
Wortendyke, Nicholas Doremus. Asst. Chf. Engr., Board of Street and Water Commrs., City Hall (Res., 108 Bentley Ave.), Jersey City, N. J.	Feb. 1, 1899
Wortham, John Root. 225 Coronado Blk., Greeley, Colo. (*Jun., Oct. 31, 1905*)	Oct. 7, 1908
Wrigley, Harry Blakemore. Mech. Engr., Dodge Mfg. Co., 815 Arch St., Philadelphia, Pa	Nov. 6, 1907
Wyman, Alfred Marshall. Asst. Engr., Public Service Comm., First Dist., 154 Nassau St., New York City (Res., 24 Rutledge Ave., East Orange, N. J.). (*Jun., Jan. 2, 1906*)	Mar. 2, 1909
Yappen, Adolph. Dist. Carpenter, C., M. & St. P. Ry., Western Ave. (Res., Cor., N. California and Grand Avenues), Chicago, Ill	June 1, 1909
Yates, Bruce Clinton. Asst. Chf. Engr., Homestake Min. Co., Lead, S. Dak	June 7, 1905
Yates, Eugene Adams. Care, Fraser, Brace & Co., 1328 Broadway, New York City. (*Jun., Oct. 3, 1905*)	Oct. 2, 1907
Yates, Joseph Johnson. Bridge Engr., C. R. R. of N. J., 143 Liberty St., New York City	May 2, 1906
Yates, William Henry. Board of Water Supply, 299 Broadway, New York City. (*Jun., Feb. 2, 1904*)	Jan. 8, 1908
Yen, Te Ching. Asst. Chf. Engr., Szechuen Chuenhan Ry. Co., Ichang, China. (*Jun., Dec. 1, 1903*)	April 1, 1908
Yeo, William Herbert Watt. Junior Engr., U. S. Reclamation Service, Las Cruces, N. Mex	Feb. 1, 1910
Young, Charles Newton. 780 Joost Ave., San Francisco, Cal	Feb. 2, 1909
Young, Henry Amerman. Civ. and San. Engr., 19 Beaver St., New York City (Res., 18 Belmont Ave., Yonkers, N. Y.). (*Jun., Mar. 5, 1901*)	Dec. 2, 1903
Young, Lewis Maxwell. Care, The Concrete Steel Co., Cor., Main and Shetucket Sts., Norwich, Conn	April 6, 1909
Zabriskie, Albert Menger. Asst. Engr., C. R. R. Co. of N. J., 143 Liberty St., New York City	Dec. 4, 1907
Zachry, John Low. Asst. City Engr., 210 Spring St., Atlanta, Ga	Nov. 7, 1906
Zimmermann, Walter Gustaf. Contr. Mgr. for the Duluth and Northern Michigan Dist. of Am. Bridge Co. of N. Y., Columbia Bldg., Duluth, Minn	Oct. 7, 1908
Zorn, George Washington. Hydr. and Gen. Eng., Germania, Wyo	Dec. 7, 1904

Associate Members, 2 112.

ASSOCIATES.

[Assoc. Am. Soc. C. E.]

	Date of Membership
Ackerman, Ernest Robinson. 1 Broadway, New York City	May 1, 1900
Ambler, Daniel Griffith. Litchfield, Conn	Mar. 7, 1906
Anderson, Robert. Vice-Pres., The Ferro-Concrete Constr. Co., 2461 Grandin Rd., Cincinnati, Ohio	Nov. 6, 1907
Atwell, Harry Hurd. 2305 Geddes Ave., Ann Arbor, Mich. (*Jun., Mar. 31, 1908*)	Jan. 4, 1910
Auchincloss, John Winthrop. 22 William St., New York City	April 2, 1901
Belden, Edgar Tweedy. Sales Mgr., Farnum Cheshire Lime Co., Pittsfield Lime Co., Pittsfield, Mass	Mar. 5, 1901
Belknap, Robert Ernest. Chicago Sales Agt., The Pennsylvania Steel Co., 193 Michigan Ave., Room 1007, Chicago, Ill	Jan. 3, 1911
Belzner, Theodore. Bridge Insp. (Maintenance); Insp., Steel Constr., Williamsburgh Bridge, Dept. of Bridges, City of New York, 84 Broadway, Brooklyn, N. Y. (Res., 614 West 135th St., New York City). (*Jun., Oct. 5, 1897*)	May 3, 1910
Bennett, Leslie J. Secy., Buffalo Cement Co., 110 Franklin St., Buffalo, N. Y	Jan. 7, 1902
Bent, Stedman. Overbrook, Pa	Dec. 2, 1902
Bernegau, Rudolf Caspar Carl Marie. 127 Fulton St., New York City	Feb. 3, 1903
Bogart, Samuel Stockton. 15 Broad St., New York City	April 7, 1886
Bouton, Harold. Counsellor at Law and Cons. Engr., 2 Rector St., New York City. (*Jun., May 2, 1899*)	Mar. 7, 1906
Bradley, Charles Whiting. Chesapeake & Ohio Ry. Co., Richmond, Va	June 19, 1891
Braine, Lawrence Fulton. Vice-Pres., The Rail Joint Co., New York City.	Sept. 6, 1898
Bromley, Albert Henry, Jr. Concrete Engr., 5113 Market St., Philadelphia, Pa	Feb. 2, 1909
Brooks, David Walker. Clinton Bldg., Columbus, Ohio	Dec. 5, 1906
Brown, John Griffiths. Contr. Engr., Witherspoon Bldg., Philadelphia, Pa	July 9, 1906
Brown, Joseph Henry, Jr. Mech. Engr. with Sullivan Machinery Co. of Chicago, 30 Church St., New York City	June 30, 1910
Brown, Thane Ross. With Wisconsin Bridge & Iron Co., North Milwaukee, Wis. (*Jun., Mar. 31, 1896*)	Oct. 2, 1900
Bruce, John Moffatt. Gen. Sales Mgr., United Mfrs., 250 West 54th St., New York City	Jan. 3, 1906
Burnham, George, Jr. Director, Baldwin Locomotive Works, 1218 Chestnut St., Philadelphia, Pa. (*Jun., Jan. 6, 1875*)	July 2, 1890
Burrows, George Lord. Saginaw, W. S., Mich	Feb. 3, 1886
Caird, James Morton. Chemist and Bacteriologist, 271 River St., Troy, N. Y	Oct. 5, 1904
Chapman, Mellville Douglas. Broker, 80 Broadway, New York City	Sept. 1, 1896
Chaussé, Alcide. City Archt. and Supt. of Bldgs., P. O. Box 259, Montreal, Que., Canada	April 6, 1904
Christian, Charles Meriwether. 24 News Press Bldg., Poughkeepsie, N. Y	Nov. 1, 1910
Church, Irving Porter. Prof. of Applied Mechanics and Hydraulics, Cornell Univ., Ithaca, N. Y	Oct. 1, 1901
Clark, Ludlow Victor. 619 Harrison Bldg., Philadelphia, Pa	Oct. 4, 1892
Codwise, Henry Rogers. Asst. Prof. of Civ. Eng., Polytechnic Inst. of Brooklyn, Brooklyn, N. Y. (*Jun., April 2, 1901*)	April 6, 1909
Colby, Safford Kinkead. Treas., Pierson, Roeding & Co., 409 Monadnock Bldg., San Francisco, Cal. (*Jun., Mar. 5, 1895*)	Jan. 6, 1904
Cole, George Nathan. Eastern Representative, Cross Horizontal Folding & Warehouse Door Co., 1328 Broadway, New York City	Oct. 2, 1907
Colsten, Albert Lloyd. Cons. Engr., 1556 Seventy-third St., Brooklyn, N. Y	Sept. 3, 1901
Compton, Alfred G. Prof. of Physics, The Coll. of the City of New York, Convent Ave. and 139th St. (Res., 40 West 126th St.), New York City.	Sept. 5, 1877

	Date of Membership
CONARD, WILLIAM ROBERTS. Inspections and Tests of Materials, Room 5, Savings Institution Bldg., Burlington, N. J.	Jan. 3, 1906
CONNOR, EDWARD JAMES. 59 Pearl St., New York City	Jan. 31, 1911
CONSTANCE, EDWARD CARTWRIGHT. Surv., U. S. Engr. Office, Custom House, St. Louis, Mo. (*Jun., Dec. 6, 1904*)	Feb. 6, 1907
COPELAND, WILLIAM ROGERS. Chf. Chemist, Board of Public Service, Water Dept., Columbus, Ohio	Feb. 4, 1902
COUNTY, ALBERT JOHN. Asst. to Second Vice-Pres., P. R. R. Co., 225 Broad St. Station, Philadelphia, Pa.	Aug. 31, 1909
CUNTZ, WILLIAM COOPER. Care, Goldschmidt Thermit Co., 90 West St., New York City	Sept. 6, 1910
CURREY, JESSE ALBERT. 1009 Board of Trade, Portland, Ore.	Feb. 1, 1910
CURRIER, CHARLES GILMAN. 313 West 102d St., New York City	June 21, 1894
CUSHMAN, ALLERTON SEWARD. Director, Inst. of Industrial Research, Washington, D. C.	Nov. 8, 1909
DAILEY, JOHN ALEXANDER. 260 Glenwood Ave., East Orange, N. J.	Sept. 7, 1904
DENIO, GEORGE LA PIERRE. 15 East Dayton St., Ridgewood, N. J.	July 9, 1906
DEWEY, CHARLES ELLIS. 46 Bank Bldg., Watertown, N. Y.	Nov. 5, 1901
DE WYRALL, CYRIL. Chf. Insp., Interborough Rap. Trans. Co., Subway Div., New York City	Feb. 6, 1907
DIVEN, JOHN M. Care, Light & Water Co., George St., Charleston, S. C.	Sept. 10, 1891
DOUGLASS, ANTHONY CHILEON. Mayor, Niagara Falls, N. Y.	April 30, 1895
DRUMMOND, THOMAS JOSEPH. Pres., Lake Superior Corporation, Montreal, Que., Canada	Mar. 6, 1894
ECKEL, EDWIN CLARENCE. Cons. Engr. and Geologist, 208 Munsey Bldg., Washington, D. C.	Mar. 5, 1901
EGLEE, CHARLES HENRY. Gen. Mgr., Ambursen Hydr. Constr. Co., 176 Federal St., Boston, Mass.	July 10, 1907
ELLIOTT, HOWARD. Pres., N. P. Ry., St. Paul, Minn.	June 5, 1900
FARRELL, EDWARD JAMES. 159 West 125th St., New York City	June 6, 1899
FERRIS, JAMES JOSEPH. Supt., F. M. Stillman Co., Gen. Contrs., 26 Exchange Pl., Jersey City, N. J.	July 10, 1907
FISHBURNE, EDWARD BELL, JR. Pres., Hoge Memorial Military Academy, Blackstone, Va.	Dec. 5, 1899
FISK, WILBUR CHAPMAN. 30 Church St., New York City	Oct. 4, 1892
FOSTER, CLARENCE MARVIN. Secy., Meacham & Wright Co., 805 Corn Exchange Bank Bldg., Chicago, Ill.	Jan. 31, 1899
FROST, GEORGE HENRY. Pres. and Treas., The Eng. News Pub. Co., 220 Broadway, New York City	Jan. 4, 1882
FUTAMI, KYOSABURO. Prof. of Civ. Eng., Kyoto Imperial Univ., Kyoto, Japan	June 5, 1889
GAINES, FRANKLIN LINCOLN. 236 So. Fuller St., Grand Rapids, Mich.	April 1, 1902
GILDERSLEEVE, ALGER CROCHERON. 215 West 125th St., New York City. (*Jun., Feb. 6, 1894*)	April 4, 1899
GILMORE, ALVIN LEROY. 318 West 57th St., New York City. (*Jun., April 6, 1909*)	Oct. 4, 1910
GOLDSBOROUGH, JOHN BYRON. Gen. Mgr., Jules Breuchaud Constr. Co., 290 Broadway, New York City	April 4, 1899
GOODELL, JOHN MILTON. Editor, *Engineering Record,* 239 West 39th St., New York City	July 29, 1891
GRAHAM, WILLIAM WOODMAN. Care, E. Stahlknecht & Co., Durango, Mexico.	Dec. 6, 1898
GRAVES, EDWARD MICHAEL. 17 Commercial Bank Bldg., Cleveland, Ohio.	Mar. 2, 1909
GREEN, FREDERICK WILLIAM. Gen. Supt., L. & A. Ry., Stamps, Ark.	May 1, 1907
GREEN, HOWARD BURKHARDT. Sales Agt., Lehigh Portland Cement Co., 1218 Pennsylvania Bldg., Philadelphia, Pa.	Mar. 4, 1908
GUNTHER, CHARLES OTTO. Prof. and Head of Dept. of Math., Stevens Inst. of Technology, Hoboken, N. J.	Sept. 6, 1910
HARDWICKE, ALAN HYDE GARDNER. Gluck Bldg., Niagara Falls, N. Y.	June 4, 1884
HARRISON, LOUIS BALDWIN. Cons. and Contr. Engr., 220 Broadway, New York City	May 5, 1896
HARTMANN, ERNEST FREDERICK. Pres., Carbolineum Wood Preserving Co., 182 Franklin St., New York City	Jan. 4, 1910
HARTRANFT, WILLIAM GARRIGUES. Pres., Wm. G. Hartranft Cement Co., Real Estate Trust Bldg., Philadelphia, Pa.	May 3, 1898
HAYS, JOHN COFFEE. Visalia, Cal.	May 4, 1909

	Date of Membership
Hayward, Harrison Washburn. Asst. Prof., Applied Mechanics, Mass. Inst. Tech., Boston, Mass.	June 6, 1906
Hazen, John Vose. Prof. of Civ. Eng., Dartmouth Coll., Hanover, N. H.	June 5, 1889
Healy, John Robert. 430 West 118th St., New York City	Jan. 8, 1908
Herron, George Merrick. Care, Standard Oil Co., Bin 12, Bakersfield, Cal. (*Jun., April 2, 1907*)	Feb. 2, 1909
Howe, James Vance. Instr. in Civ. Eng., Union Coll., Schenectady, N. Y.	Nov. 30, 1909
Hughes, Harold Lincoln. Sales Mgr. and Res. Engr., United States Steel Products Export Co., G. P. O. Box 384, Sydney, New South Wales, Australia	April 1, 1908
Hunt, Carlton Eugene. With Westinghouse, Church, Kerr & Co., 10 Bridge St., New York City	Oct. 3, 1906
Hurst, George Joseph. 558 West 184th St., New York City	Nov. 7, 1906
Huston, James Archibald. Gen. Mgr., Am. Bridge Co., 826 Frick Bldg., Pittsburg, Pa.	Aug. 31, 1897
Jacoby, Henry Sylvester. Prof. of Bridge Eng., Cornell Univ., 7 Reservoir Ave., Ithaca, N. Y.	Nov. 5, 1890
Johnson, Arthur Augustine. Sanford Ave. and 21st St., Flushing, N. Y.	Sept. 2, 1908
Jordan, Harry Edward. Chemical Engr., Indianapolis Water Co., Indianapolis, Ind.	Aug. 31, 1909
Kaltenbach, Henry Julius. Park Hill, Yonkers, N. Y.	June 3, 1902
Karner, William Josiah. Secy. and Treas., Bowne & Co., Inc., 81 Beaver St., New York City	July 2, 1890
Keller, Otto Balthazar. Eng. and Govt. Representative of Keuffel & Esser Co., 127 Fulton St., New York City	Feb. 3, 1903
Kenyon, William John Charles. Vice-Pres. and Gen Mgr., George W. Jackson, Inc., 31 East Division St., Chicago, Ill.	May 31, 1910
King, Harry Wheelock. Vice-Pres., The King Bridge Co., Cleveland, Ohio.	June 19, 1891
King, Wallace, Jr. Vice-Pres., United Bldg. Material Co., 30 Church St., Room 1012, New York City	Dec. 4, 1900
Kornfeld, Alfred Ephraim. Mgr., *Engineering News*, 220 Broadway, New York City	Oct. 7, 1908
Lally, John Michael. Asst. Supt. of Constr., Grand Central Terminal Impvt., N. Y. C. & H. R. R. R., 437 Spencer Pl., Bronx, New York City.	Sept. 2, 1908
Leather, Basil Henry. 1133 Broadway, New York City	June 1, 1904
Lee, Robert Hileman. Asst. Engr., Bridge Dept., Cuyahoga County, 2216 Bellfield Ave., Cleveland Heights, Ohio	May 2, 1906
Lesley, Robert Whitman. Pres., Am. Cement Co., 604 Pennsylvania Bldg., Philadelphia, Pa.	Jan. 31, 1893
Liebmann, Alfred. 57 West 58th St., New York City	June 3, 1902
Lober, John Baptiste. 1230 Land Title Bldg., Philadelphia, Pa.	July 9, 1906
Lundberg, John Hervid. 299 Albany Ave., Brooklyn, N. Y.	April 3, 1907
MacGregor, John. Engr., The United States Fidelity & Guaranty Co. of Baltimore, 126 No. Ashland St., Buffalo, N. Y.	June 2, 1903
McBurney, Henry. Care, A. W. Buel, 15 William St., New York City. (*Jun., Jan. 5, 1904*)	Nov. 6, 1907
McIntire, Thomas Burton. 52 Vernon Pl., Sherwood Park, Yonkers, N. Y. (*Jun., Mar. 1, 1904*)	Oct. 3, 1906
McKenna, Charles Francis. Chemist, 221 Pearl St., New York City	June 5, 1894
Maignen, Jean Prosper Auguste. Filtration Engr., 52 North 13th St., Philadelphia, Pa.	Oct. 3, 1899
May, Theodore Martin. Address unknown	Dec. 7, 1904
Meriwether, Coleman. Pres. and Chf. Engr., Lock Joint Pipe Co., 165 Broadway, New York City	Feb. 7, 1906
Meyer, Henry Coddington, Jr. Cons. Mech. Engr., 1 Madison Ave., New York City (Res., Montclair, N. J.) (*Jun., Jan. 3, 1893*)	Dec. 28, 1900
Monahan, John Joseph. Builder, West Chelmsford, Mass.	June 1, 1904
Monks, John, Jr. 82 Beaver St., New York City	May 31, 1898
Morris, Davis Harrington. Special Agt., Central Union Telephone Co., Dayton, Ohio	Nov. 6, 1907
Moxham, Arthur James. Room 926, du Pont Bldg., Wilmington, Del.	Nov. 2, 1887
Moyer, Albert. 200 Fifth Ave., New York City	Feb. 7, 1906
Oastler, William Churchill. 200 West 56th St., New York City	Mar. 31, 1891
Odell, Rutledge Irving. Vice-Pres., The Tomkins Cove Stone Co, Tomkins Cove, N. Y.	Oct. 1, 1895
Olds, William Clarence. Erie, Pa.	Nov. 3, 1903

ASSOCIATES P-T

	Date of Membership
Packard, Ralph Gooding, Jr. Vice-Pres., R. G. Packard Co., 130 Pearl St., New York City	Sept. 3, 1901
Palmer, William Pendleton. Pres., Am. Steel & Wire Co., Western Reserve Bldg., Cleveland, Ohio	Mar. 3, 1896
Parsons, George Wellman. Cons. Engr., Pennsylvania Steel Co., Steelton, Pa	Sept. 3, 1884
Patton, Alfred Gaunt. Engr. and Chf. of the Special Hazard Dept. of the New York Fire Insurance Exchange, The Oaks, Fisher's Lane, Germantown, Philadelphia, Pa	Dec. 6, 1905
Phelps, Earle Bernard. Cons. San. Engr., 30 Church St., New York City.	Mar. 4, 1908
Phillips, Henry Ayling. Archt., 120 Tremont St., Boston, Mass	April 7, 1886
Phipps, Lawrence Cowle. 1154 East Colfax Ave., Denver, Colo	Jan. 31, 1899
Pinchot, Gifford. 1615 Rhode Island Ave., N. W., Washington, D. C.	Mar. 4, 1902
Polk, William Anderson. Chamber of Commerce Bldg., Baltimore, Md.	May 4, 1897
Pomeroy, Lewis Roberts. Chf. Engr., Ry. and Industrial Div., J. G. White & Co., 43 Exchange Pl., New York City	April 2, 1890
Poorman, Alfred Peter. Asst. Prof. of Mechanics, Purdue Univ., 127 Sylvia St., West Lafayette, Ind	Oct. 7, 1908
Quilty, Thomas Frank. Gen. Eng. Contr. (John J. O'Heron & Co.), 6 Wabash Ave., Chicago, Ill	April 5, 1905
Quincy, Charles Frederick. 90 West St., New York City	Feb. 4, 1896
Ransome, Ernest Leslie. Cons. Concrete Engr., 910 Madison Ave., Plainfield, N. J	June 5, 1894
Ray, David Heydorn. Chf. Engr., Bureau of Bldgs. of New York City, 220 Fourth Ave. (Res., 329 Edgecombe Ave.), New York City. *(Jun., Oct. 7, 1902)*	Mar. 1, 1910
Rowntree, Bernard. Eastern Engr., Burdett-Rowntree Mfg. Co., 147 West 26th St., New York City	April 5, 1910
Ryan, Laurence Patrick. Contr. (T. L. Ryan & Co.), 4047 Kenmore Ave., Chicago, Ill	Aug. 31, 1909
Saeger, Charles Marshall. Gen. Mgr., Coplay Cement Mfg. Co., 1320 Hamilton St., Allentown, Pa	May 2, 1893
Sass, Charles William. 465 East 140th St., New York City	Nov. 4, 1908
Scribner, Gilbert Hilton, Jr. Engr. and Contr., 184 La Salle St., Chicago, Ill	April 5, 1905
Sell, William Drumm. Chf. Engr. and Asst. Gen. Mgr., Gallego Coal & Land Co. and Ohio Timber Co., Room 400 National City Bank Bldg., Charleston, Kanawha Co., W. Va. *(Jun., Dec. 3, 1891)*	May 2, 1899
Smith, Albert. Prof. of Structural Eng., Purdue Univ., 1022 Seventh St., West Lafayette, Ind	April 3, 1907
Smith, Cameron C. Pres. and Gen. Mgr., Union Steel Casting Co., Pittsburg, Pa	June 5, 1907
Smith, Francis Hopkinson. 16 Exchange Pl., New York City	April 5, 1892
Smith, Francis Vinton. Hotel Belnord, 86th St. and Broadway, New York City	Oct. 7, 1908
Smith, Herbert Stearns Squier. Prof. of Civ. Eng., Princeton Univ., 58 University Pl., Princeton, N. J	Sept. 10, 1891
Smith, Walter Townsend. 215 West 23d St., Box 717, New York City.	Oct. 7, 1908
Snare, Frederick. Pres., The Snare & Triest Co., Contr. Engrs., 143 Liberty St., New York City	Oct. 6, 1903
Sommer, Albert. Cons. Chemist of The Texas Co., 17 Battery Pl., New York City	Feb. 1, 1910
Speed, James Breckinridge. 325 West Main St., Louisville, Ky	May 2, 1888
Stilson, Minott Augur Osborn. 172 Chestnut Ave., Waterbury, Conn	Feb. 5, 1908
Stowe, Charles Brown. Pres., The Stowe Fuller Co., Cleveland, Ohio.	Oct. 4, 1898
Stroebe, George Gottlieb. Care, Bureau of Public Works, Manila, Philippine Islands	Nov. 4, 1908
Struckmann, Holger. Chf. Engr. and Gen. Mgr., Iola Portland Cement Co., Iola, Kans	Nov. 30, 1909
Talbot, Frank Mayhew. Pres. of F. M. Talbot Co., Contrs., 1 Madison Ave., New York City (Res., Glen Ridge, N. J.)	May 4, 1909
Tenney, George Oliver. Pres. and Treas., Atlantic Bitulithic Co., Richmond, Va. *(Jun., Sept. 7, 1887)*	Feb. 5, 1901
Thompson, Edward Percival. Chf. Engr., The Mindoro Development Co., Manila, Philippine Islands	June 5, 1907
Thorn, Alfred William. Gen. Mgr., Thorn Cement Co., 445 Delaware Ave., Buffalo, N. Y	Oct. 2, 1900
Toch, Maximilian. Chemist for Toch Bros., 320 Fifth Ave., Room 709, New York City	Sept. 1, 1903

	Date of Membership
Tomkins, Calvin. Commr. of Docks, Pier A, North River, New York City.	Jan. 6, 1886
Townsend, Frederick Eugene. 311 West 95th St., New York City......	April 6, 1909
Trautwine, John Cresson, Jr. 257 South 4th St., Philadelphia, Pa.....	Dec. 5, 1888
Turrill, Sherman Marsh. Engr. with Ralph Modjeski, 1750 Monadnock Blk., Chicago, Ill..............	Oct. 1, 1901
Usina, Domingo Anthony. Civ. Engr. and Counselor in Patent Law, 71 Broadway, New York City..............	Mar. 1, 1905
Van Name, Joseph Mason. 1258 Bergen St., Brooklyn, N. Y..........	April 3, 1907
von Schrenk, Hermann. Supervisor, Timber Preservation, Frisco-Rock Island System, Tower Grove and Flad Avenues, St. Louis, Mo.....	July 10, 1907
Warder, John Haines. Secy., Western Society of Engrs., 1735 Monadnock Blk., Chicago, Ill..............	Mar. 7, 1888
Watson, Merrill. 12 No. Arlington Ave., East Orange, N. J.........	Oct. 7, 1902
Watt, James Robert. Pres., United Constr. Co., 467 Broadway, Albany, N. Y..............	June 3, 1908
Weber, George Adam. 71 Courtland Ave., Stamford, Conn............	Feb. 6, 1900
Wells, Joseph Agur. The Fairbanks Co., Broome and Elm Sts., New York City..............	Jan. 7, 1896
Willson, Frederick Newton. Prof. of Descriptive Geometry and Technical Drawing, Princeton Univ., Box 63, Princeton, N. J. (*Jun., Sept. 5, 1883*)..............	Oct. 4, 1892
Woodbury, John McGaw. Care, Gen. Elec. Co., 30 Church St., New York City..............	Feb. 7, 1906
Wrenn, James Francis. Gen. Supt. of Constr. for Jno. B. Carter Co., 87 Broadway, Frostburg, Md..............	Sept. 6, 1905
Young, Charles Griffith. Engr. and Contr., 60 Wall St., New York City.	Mar. 6, 1894

Associates, 172.

JUNIORS.

[Jun. Am. Soc. C. E.]

	Date of Membership
Abrams, Duff Andrew. Associate, Eng. Experiment Station, Univ. of Illinois, Urbana, Ill	Jan. 2, 1906
Abrons, Louis William. Asst. Engr., Bureau of Public Works, Manila, Philippine Islands	Aug. 31, 1909
Ackemann, Henry Conrad. 254 McMillen, Portland, Ore	Feb. 1, 1910
Ackerman, Arthur Pope. Insp., Care, Board of Water Supply, Vail Gate, N. Y	June 30, 1910
Adey, John Seager. The Sutherland, 611 West 158th St., New York City.	Feb. 3, 1903
Affleck, Myron Hopkins Strong. Asst. Engr., Am. Extractor Corporation, 10 Weybosset St., Providence, R. I	Feb. 4, 1908
Anderson, Lowrey Wallace. Supt. and Chf. Engr., The Pecos Val. Southern Ry. Co., Pecos, Tex	April 6, 1909
Andrews, George Crowell. Asst. Engr. in Chg., Contract 10, New York State Barge Canal, Fulton, N. Y	Aug. 31, 1909
Andrus, Leonard Alexander. 411 Lewis Bldg., Portland, Ore	Jan. 7, 1908
Appel, Harris Arkush. P. O. Box 504, Colorado Springs, Colo	Mar. 2, 1909
Armstrong, George Simpson, Jr. Care, Carpenter Steel Co., Reading, Pa.	Jan. 5, 1909
Ashbrook, Chester Daniel. Asst. Engr., King County, Seattle, Wash	May 4, 1909
Atwood, Chester Ely. Hammil Blk., Great Falls, Mont	Feb. 1, 1910
Atwood, William Bartlett. Vice-Pres. and Gen. Mgr., Geneva & Auburn Ry. Co., Seneca Falls, N. Y	April 30, 1907
Auten, Claude Isaac. City Engr., Flint, Mich	Sept. 1, 1908
Ayres, Louis Evans. With Gardner S. Williams, Cons. Engr., Ann Arbor, Mich	Dec. 1, 1908
Backus, Murray James. Asst. Engr., Central Fortuna, Ponce, Porto Rico.	Oct. 4, 1910
Bailey, Clifton George. Sub-Insp., U. S. Naval Station, Key West, Fla.	Sept. 6, 1910
Baines, William Henry. 569 Jersey Ave., Jersey City, N. J	Sept. 6, 1910
Baker, Ned Duncan. Engr. Insp., California State Board of Health, Sacramento, Cal	Dec. 6, 1910
Baldridge, James Ramsey. Superintending Engr., Hennebique Constr. Co., 219 Jefferson Ave., Scranton, Pa	Dec. 4, 1906
Banker, Edward Warren. Capt., U. S. Marines; Asst. Quartermaster, Navy Yard, Philadelphia, Pa	Mar. 1, 1904
Banks, Charles Wilbur. Asst. Engr., Board of Water Supply, Box 456, Pleasantville, N. Y	Feb. 5, 1907
Banta, Russell Vincent. 11 Washington Pl., Ridgewood, N. J	May 31, 1910
Barker, James Madison. Engr., Architectural Dept., Canadian Pacific Ry. Co., Montreal, Que., Canada	Oct. 1, 1907
Barker, Ludlow Osmond, Jr. U. S. Engr. Office, Pittsburg, Pa	Jan. 3, 1907
Barlow, Alfred Eugene, Jr. 854 Lafayette Ave., Brooklyn, N. Y	April 2, 1907
Barnes, Harry Everett. Asst. Engr., Board of Water Supply, Box 113, Stone Ridge, Ulster Co., N. Y	Mar. 2, 1909
Barney, William Joshua. Secy., Dept. of Docks and Ferries, Pier A, North River, New York City	April 5, 1910
Barshell, Frederick Bayard. Asst. Civ. Engr., Public Service Comm., First Dist., State of New York, 154 Nassau St., New York City	May 1, 1906
Bartholomew, Tracy. Mgr., Western Cement Products Co., 508 Ideal Bldg., Denver, Colo	Jan. 3, 1911
Bates, Lindon, Jr. Cons. Engr., Western Eng. Corporation, 115 Broadway, New York City	Jan. 3, 1907
Battie, Herbert Scandlin. Box 126, Harrisburg, Pa	Dec. 1, 1908
Beard, Vivian Dangerfield. Instr. in Civ. Eng. Dept. of Iowa State Coll. Station A, Ames, Iowa	April 5, 1910
Becker, Rudolph Conrad. 339 East 68th St., New York City	April 30, 1907
Beebe, John Cleaveland. Junior Engr., U. S. Geological Survey, Helena, Mont	Nov. 1, 1910
Beebee, Ralph Agustus. 551 University Ave., Palo Alto, Cal	Sept. 1, 1908
Behrman, Isadore. 1121 East Baltimore St., Baltimore, Md	Oct. 4, 1910
Bell, Howard Fred. Asst. Engr. in Chg. of Constr. of Sewerage System, Jefferson, Ohio	May 31, 1910

	Date of Membership
Bellows, Sidney Raymond. Barge Canal Office, Room 82, Parker Bldg., Schenectady, N. Y.	Oct. 1, 1907
Benedict, Farrand Northrop. Engr., Thomas Crimmins Contr. Co., 444 East 69th St., New York City	June 4, 1907
Benedict, Nathan. Asst. Engr., United Fruit Co., Limon, Costa Rica	Oct. 1, 1907
Bennet, Orville Green, Jr. Care, The Okonite Co., 253 Broadway, New York City	June 5, 1906
Bergman, Harry Montifiore. Asst. Engr., Godwin Constr. Co., 30 Church St., New York City	May 4, 1909
Bernstein, Lester. Field Engr., B. & O. R. R., B. & O. Bldg., Baltimore, Md	Feb. 28, 1905
Beswick, James Everett. Asst. Engr., Board of Water Supply, New York City (Res., 5 Wiener Pl., Tompkinsville, N. Y.)	July 1, 1909
Bhâgwat, Shanker Râmchandra. Lecturer in Eng., Coll. of Science, 192 Sadashiv Peth, Poona City, India	Oct. 4, 1910
Bigelow, William Walter. Care, J. R. Worcester & Co., Waltham, Mass.	Feb. 1, 1910
Biggs, Carroll Addison. Designer for William G. Fargo, 303 Commonwealth Bldg., Jackson, Mich	Sept. 1, 1908
Billwiller, Ernest Oswald. 167 Washington Ave., San José, Cal	Nov. 8, 1909
Bilyeu, Charles Smith. Operating Dept., Am. Bridge Co., Ambridge Pa.	Dec. 1, 1908
Bishop, Hiram Nelson. 319 Boren Ave., Seattle, Wash	Oct. 1, 1907
Bishop, Lyman Edgar. Care, The Goldsborough Co., 514 First National Bank Bldg., Denver, Colo	May 4, 1909
Black, Roger Derby. 1st Lieut., Corps of Engrs., U. S. A., U. S. Engr. Office, Albany, N. Y	Jan. 3, 1905
Blackburn, Nathaniel Townsend. U. S. Junior Engr., U. S. Engr. Office, Galveston, Tex	Sept. 6, 1904
Bluhm, Herman William. Draftsman, Isthmian Canal Comm., Corozal, Canal Zone, Panama	Nov. 8, 1909
Bock, Carl August. West Side, Iowa	Aug. 31, 1909
Bogert, Clinton Lathrop. Asst. Engr., Headquarters Dept., Board of Water Supply, 299 Broadway, New York City	Sept. 1, 1908
Boig, Alexander Fletcher. Draftsman, Penn Bridge Co., Beaver Falls, Pa	Nov. 1, 1910
Bolton, Frank Leonard. 34 Clinton Ave., North, Rochester, N. Y	June 30, 1910
Borland, Bruce. 1508 Borland Blk., Chicago, Ill	Mar. 3, 1903
Bornefeld, Charles Fowler. Insp., Galveston Causeway, 2509 Broadway, Galveston, Tex	May 31, 1910
Bortin, Harry. Asst. Engr. in Chg., Valuation Dept., U. P. R. R., 11th and Farnum Sts., Omaha, Nebr	Sept. 6, 1910
Bowditch, Ernest W. Landscape Gardener and Civ. Engr., 68 Devonshire St., Boston, Mass	Feb. 3, 1875
Bowerman, Edwin Roy. Fairport, N. Y	Jan. 3, 1911
Brainard, Albert Sereno. 9 Burnside Ave., East Hartford, Conn	Oct. 6, 1908
Brainerd, Harold Affleck. With Am. Bridge Co., Elmira, N. Y	Nov. 30, 1909
Breitzke, Charles Frederick. Asst. Engr., N. Y. Board of Water Supply, Cold Spring-on-Hudson, N. Y	Dec. 3, 1907
Bremer, Lewis Paul. Address unknown	Feb. 6, 1906
Brennan, Joseph Lawrence. 223 West 167th St., New York City	Jan. 5, 1909
Breuchaud, Jules Rowley. 290 Broadway, New York City	Nov. 1, 1904
Brewer, Willard Seymour. City Engr.'s Office, Hartford, Conn	Sept. 3, 1907
Broadhurst, William George. Contr. Engr., 245 Passaic St., Hackensack, N. J	Sept. 3, 1907
Brooks, John Nixon. 240 W. State St., Trenton, N. J	Nov. 8, 1909
Brooks, Josiah Richardson. 703 E. High St., Mt. Vernon, Ohio	Feb. 2, 1909
Brown, Arthur Robert. Office of Asst. Chf. Engr., Culebra, Canal Zone, Panama	Jan. 2, 1906
Brown, Claude Osgood. Asst. Engr., Bureau of Public Works, Manila, Philippine Islands	Oct. 5, 1909
Brown, David Harell. Engr., M. of W., Salt Lake & Ogden Ry., 461 Main St., Salt Lake City, Utah	Feb. 4, 1908
Brown, Grover Charles. Junior Engr., Am. Section, International Waterways Comm., 727 Elmwood Ave., Buffalo, N. Y	June 2, 1908
Brown, William Clinton. Mech. Engr., 512 William St., Montreal, Que., Canada	Sept. 1, 1886
Brua, Elmer George. Care, Associated Oil Co., Wells-Fargo Bldg., San Francisco, Cal	Feb. 6, 1906
Bryan, George, Jr. Bridge Dept., C. & N. W. Ry. Co., 1125 Morse Ave., Chicago, Ill	Jan. 3, 1911
Buchanan, Nathan Booker. Huntsville, Ala	Mar. 1, 1910
Budell, Alfred Edward. 95 Liberty St., New York City	Oct. 1, 1907
Buell, Walter Augustus. 540 West 113th St., New York City	Oct. 4, 1910
Buettner, Otto George Henry. Care, Interborough Rap. Trans. Co., 32 Park Pl., New York City	May 31, 1910
Burnham, George Earle. 27 Rand St., Central Falls, R. I	Oct. 1, 1907
Burpee, George William. With Westinghouse, Church, Kerr & Co. of New York City, P. O. Box 31, Sta. B, Worcester, Mass	Sept. 3, 1907

	Date of Membership
Burr, Myron Carlos. Civ., Hydr. and San. Engr. (Burr & Fergusson), Loo Bldg., Vancouver, B. C., Canada	May 4, 1909
Burton, Wayne Joseph. Designing Engr., Mo. Pac. Ry., 307 Title Guaranty Bldg., St. Louis, Mo.	Sept. 4, 1906
Bushell, Arthur William. Care, Morgan Eng. Co., Poplar Bluff, Mo.	Oct. 1, 1907
Bushnell, Howard Emory. Contr. Engr., Levering & Garrigues Co., Firemans Bldg., Newark, N. J.	Mar. 6, 1906
Bushway, Walter Benjamin. Asst. Engr., Boston Elev. Ry. Co., 28 Hurlbut St., Cambridge, Mass.	Nov. 8, 1909
Cadwallader, Wallace Laird. Asst. Engr., Elec. Traction, P. T. & T. R. R., Pennsylvania Station, New York City	Sept. 6, 1910
Cahill, James Edward. Engr., Great Lakes Dredge & Dock Co., Chamber of Commerce (Res., 1221 Gilpin Pl.), Chicago, Ill.	Mar. 31, 1908
Cahill, John Richard. 136 Belvedere St., San Francisco, Cal.	April 30, 1907
Calder, John Webster. 5520 Walnut St., Philadelphia, Pa.	Sept. 1, 1908
Caldwell, John Worde. Care, U. S. Engr. Office, McCandless Bldg., Honolulu, Hawaii	Aug. 31, 1909
Calkins, Charles Dow. Instr. in Math. and Surveying, Rensselaer Polytechnic Inst., 23 Thirteenth St., Troy, N. Y.	April 5, 1910
Cameron, Kenneth Mackenzie. Prin. Asst. Engr., Public Works Dept. (Res., 793 Hellmuth Ave.), London, Ont., Canada	Oct. 6, 1903
Cantwell, Herbert Herluin. Asst. Supervisor of Tracks, N. Y. C. & H. R. R. R., Croton, N. Y.	Dec. 3, 1907
Carbajal, Fernando. Care, Engineering Society, Lima, Peru	Jan. 7, 1908
Carlisle, Orville Berton. Designer, Am. Bridge Co. (Res., 4318 Calumet Ave.), Chicago, Ill.	Sept. 4, 1906
Carpenter, J. C. U. S. Engr., War Dept., Manila, Philippine Islands	Nov. 8, 1909
Carter, Lester Levi. Asst. Engr., Associated Pipe Line Co., Los Banos, Cal.	Sept. 3, 1907
Cartwright, Henry Hart. Surv., U. S. Govt., U. S. Engr. Office, Louisville, Ky.	Oct. 4, 1910
Cary, Richard Lucius. 23 Madison St., Princeton, N. J.	June 30, 1910
Caspari, Frederick William. Asst. Engr., Baltimore Sewerage Comm., 902 American Bldg., Baltimore, Md.	Nov. 1, 1910
Cater, Walter Day. Civ. Engr. for the Am. Cement Eng. Co., Yorktown, Va.	Nov. 30, 1909
Cefalu, Frank Dominic. U. S. Junior Engr., Departmental Service, Burrwood, La.	April 5, 1910
Chace, Amasa Manton. 81 Rhode Island Ave., Newport, R. I.	Oct. 5, 1909
Chadwick, Chester Robert. Structural Engr., Milliken Bros., Inc., Milliken, N. Y.	Feb. 5, 1907
Chafetz, Herman. 80 Pratt St., Buffalo, N. Y.	June 1, 1909
Chandler, Emerson Lawrence. Asst. Engr., New London Water and Sewer Dept. (Res., 16 Squire St.), New London, Conn.	Nov. 8, 1909
Chandler, Horace Edward. In Chg. of Dept. of Physics, Coll. of Arts and Sciences, Shantung Christian Univ., Weihsien, Shantung Province, China	Sept. 4, 1906
Chapman, Arnold Goodwin. Chf. Clerk, Dept. of State Engr. and Surv., State of New York, Albany, N. Y.	July 1, 1909
Chester, Charles Porter. With International Boundary Comm., P. O. Box 505, El Paso, Tex.	Feb. 4, 1908
Chevalier, Louis. Prin. Asst. to J E. Greiner, Cons. Engr., 606 Continental Bldg., Baltimore, Md.	May 1, 1906
Chevalier, Willard Townshend. Asst. Engr., Public Service Comm., First Dist., 23 Flatbush Ave., Brooklyn, N. Y.	April 6, 1909
Church, Elihu Cunyngham. Lecturer in Civ. Eng., Columbia Univ.; Cons. Engr., 4 East 130th St., New York City	May 1, 1906
Clark, Le Roy Walter. Asst. in Rational and Technical Mechanics, Rensselaer Polytechnic Inst., 101 Hoosick St., Troy, N. Y.	Sept. 4, 1906
Clark, William George. Cons. Engr., 1050 Spitzer Bldg., Toledo, Ohio.	April 4, 1888
Clausnitzer, John. 157 East 21st St., New York City	Mar. 3, 1903
Clayton, Henry Helm. Asst. Engr., M. of W. Dept., Mo. Pac. Ry., Kirkwood, Mo.	Dec. 3, 1907
Cleveland, Lou Baker. Civ. Engr. and Contr., Cleveland Bldg., Watertown, N. Y.	Sept. 1, 1908
Clifford, Walter Woodbridge. Asst. in Civ. Eng., Mass. Inst. Tech., 60 Oak St., Hyde Park, Mass.	Nov. 8, 1909
Closson, Edgar Stone. Asst. Engr., Public Service Comm., First Dist., 1047 East Tenth St., Brooklyn, N. Y.	Sept. 4, 1906
Coburn, Horace Butterfield, Jr. 93 West Park St., Portland, Ore.	Oct. 30, 1906
Cochran, Jerome. Designing Engr., Corrugated Bar Co., National Bank of Commerce Bldg., St. Louis, Mo.	Sept. 1, 1908
Coffin, Theodore DeLong. Katonah, N. Y.	Nov. 1, 1904
Cole, Alden Brigham. Asst. Engr., N. Y., O. & W. Ry., Carbondale, Pa.	Sept. 3, 1907

	Date of Membership
Coleman, Lester Lyman. Asst. Engr. with City Engr., 253 Carl St., San Francisco, Cal	May 31, 1910
Colgan, Robert Joseph. 226 N. 2d St., Harrisburg, Pa	Sept. 1, 1908
Colman, James Blaine Thomas. Care, Bureau of Public Works, Manila, Philippine Islands	Nov. 1, 1910
Cook, Henry Aten. 160 Fifth Ave., Room 714, New York City	Oct. 30, 1906
Cook, John Wheeler. Asst. Engr., O'Rourke Eng. Constr. Co., 345 Fifth Ave., New York City	Oct. 30, 1906
Coombs, Arthur Wellesley. (Fitzpatrick & Coombs), 1123 Broadway, New York City	Oct. 1, 1907
Corp, Henry William. Care, Manila R. R. Co., Manila, Philippine Islands.	Oct. 1, 1907
Cortright, Edwin Keen. Beverly, N. J	Feb 4, 1908
Crane, Will Edwin. 800 Walnut St., Edgewood Park, Swissvale P. O., Pittsburg, Pa	May 1, 1889
Craven, Jay Allen. Care, Florence Pumping Station, Florence, Nebr.	May 31, 1910
Croasdale, Laurence Brodhead. Delaware Water Gap, Pa	May 31, 1910
Crooks, Clinton Hervey. Asst. Engr., Rapid Transit Subway Constr. Co. (Res., 204 West 94th St.), New York City	Oct. 3, 1905
Crowell, Francis Stirling. Asst. Engr., Barge Canal Contract No. 69, Barge Canal Office, Mechanicsville, N. Y	Feb. 6, 1906
Cunningham, John Earl. Boston Elev. Ry., 101 Milk St. (Res., 2 Louisburg Sq.), Boston, Mass	Sept 5, 1905
Cunningham, John Wilbur. Draftsman, Bridge Dept., Oregon-Washington R. R. & Nav. Co., 924 Paulsen Bldg., Spokane, Wash	Aug. 31, 1909
Cunningham, Pinkney Edward. U. S. Junior Engr., P. O. Box 404, Vicksburg, Miss	July 1, 1909
Currey, John Waggoner. Deputy County Surv., Wagoner Co., Wagoner, Okla	Sept. 6, 1910
Cutler, Leon George. Care, Board of Water Supply, 165 Broadway, New York City	April 5, 1910
Cutler, Stanley Gardner. Asst. Engr., Bureau of Public Works, Manila, Philippine Islands	May 4, 1909
Dann, Alexander William. Box 404, Vicksburg, Miss	Feb. 4, 1908
Davenport, Royal William. Junior Engr., U. S. Geological Survey, 207 Tilford Bldg., Portland, Ore	Oct. 4, 1910
Davis, Charles Moss. U. S. Engr. Office, Galveston, Tex	Jan. 3, 1907
Davis, George Walker. Surv., Bureau of Lands, Manila, Philippine Islands	Feb. 4, 1908
Davis, Roland Parker. Instr. in Civ. Eng., Lincoln Hall, Cornell Univ., Ithaca, N. Y	Mar. 1, 1910
Davison, Allen Stewart. 300 Maple Ave., Swissvale Station, Pittsburg, Pa	Mar. 1, 1910
Day, Warren Ellis. Instrumentman, Oakdale Irrig. Dist., Oakdale, Cal. .	Dec. 6, 1910
Decker, Arthur James. Instr. in Civ. Eng., Univ. of Michigan; Asst. Engr., Gardner S. Williams, Room 207, New Eng. Bldg., Ann Arbor, Mich	Sept. 5, 1905
de Forest, Nora Blatch. Asst. Engr., Radley Steel Constr. Co., 18th and 19th Sts. and East River, New York City	Mar. 6, 1906
Dennie, Frank Edward. Univ. of Missouri, School of Mines and Metallurgy, Rolla, Mo	Oct. 5, 1909
Densler, Frank Haskell. Asst. Engr., Board of Water Supply, New York City, 805 Prospect Pl., Brooklyn, N. Y	July 1, 1909
Derleth, Walter Taubert. Engr. with D. J. Ryan, Contr., 723 Third Ave., Brooklyn, N. Y. (Res., 224 West 139th St., New York City)	Oct. 31, 1905
Deutschbein, Harry Johnson. Supt., Bureau of Water, 25 Quackenbush St., Albany, N. Y	Dec. 6, 1904
Dibert, Herbert McMillen. With W. & L. E. Gurley, 514 Fulton St. (Res., 1821 Fifth Ave.), Troy, N. Y	April 6, 1909
Dimmler, Charles Louis. 319 Boren St., Seattle, Wash	Oct. 1, 1907
Dittoe, William Henry. Asst. Engr., Ohio State Board of Health, Harrison Bldg., Columbus, Ohio	May 3, 1910
Dodds, David Metheny. Draftsman, Am. Bridge Co., 6223 Greenwood Ave., Chicago, Ill	Nov. 1, 1910
Doolittle, Frederick William. Asst. Prof. of Mechanics, Univ. of Wisconsin, 204 North Brooks St., Madison, Wis	April 5, 1910
Dorrance, Frank Young. Civ. Engr. with Morris Knowles, Cons. Engr., Room 2548, Oliver Bldg., Pittsburg, Pa	Feb. 5, 1907
Dougherty, Richard Erwin. Dist. Engr., N. Y. C. & H. R. R. R., Grand Central Palace, New York City	Jan. 6, 1903
Drager, Walter Louis. San. Engr., 306 Suppes Bldg., Johnstown, Pa. . .	May 3, 1910
Driggs, Edwin Leroy. Bureau of Lands, Manila, Philippine Islands	Nov. 5, 1907
Dubois, Gustavo Adolfo. Jefatura del Alcantarillado, Havana, Cuba	Sept. 1, 1908
Du Moulin, Walter Louis. Supt., The Morenci Water Co., Morenci, Ariz.	Feb. 1, 1910

	Date of Membership
Dunan, George Edmund. Chf. Engr., Apalachicola Northern R. R., Port St. Joe, Fla.	Nov. 8, 1909
Dunmire, Elijah Herbert. Asst. Loc. Engr., Cinn., Ky. & Va. Ry. Co., Lawrence, Kans.	Mar. 5, 1907
Eames, Horace Lovell. 134 Washington Ave., Bridgeport, Conn.	Jan. 7, 1908
Earl, Austin Willmott. 743 Twenty-first St., San Diego, Cal.	Dec. 1, 1908
Earle, Frank Hasbrouck, Jr. 163 North 7th St., Newark, N. J.	Dec. 4, 1906
Easton, Russell Burns. City Engr., Aberdeen and Redfield, S. Dak., Aberdeen, S. Dak.	Mar. 3, 1908
Eberspacher, Fred. U. S. Junior Engr., Box 333, Greenville, Miss.	Mar. 2, 1909
Eddy, Adolphus James. Instr. in Civ. Eng., Univ. of California, 2630 Fulton St., Berkeley, Cal.	Dec. 6, 1910
Edgerton, Glen Edgar. 2d Lieut., Corps of Engrs., U. S. A., Alaskan Board of Road Commrs., Valdez, Alaska	Nov. 8, 1909
Edmundson, Harold Bowen. Care, State Board of Public Roads, Providence, R. I.	Nov. 30, 1909
Eide, Torris. Asst. Engr., Designing Div., Board of Water Supply, 165 Broadway, New York City	Sept. 6, 1910
Elam, William Earle. Asst. Engr., Miss. Levee Board, Greenville, Miss.	Feb. 6, 1906
Ellis, Herbert Cram. Y. M. C. A. Bldg., White Plains, N. Y.	April 5, 1910
Ellsworth, Lincoln. Hudson, Ohio	May 5, 1908
Eltinge, Orville Lamont. P. O. Box 27, Fort Leavenworth, Kans.	Jan. 3, 1907
Emigh, William Chester. North Adams, Mass.	May 31, 1910
Emory, Lloyd Tilghman. Gen. Supt., Kaolin Min. Co., 6019 Main St., Germantown, Philadelphia, Pa.	Oct. 5, 1909
Entenmann, Paul Max. Asst. Engr., Public Service Comm., First Dist., 872 East 181st St., New York City	Mar. 1, 1910
Estabrook, George Mitchell. Asst. Engr with C. E. Marshall, Hempstead, N. Y.	Feb. 4, 1908
Esten, Howard Foss. 128 Cedar St., Pawtucket, R. I.	Jan. 2, 1906
Ewing, Williard Rea. 2405 S. Ridgeway Ave., Chicago, Ill.	Oct. 31, 1905
Farley, Marcus Martin. Olive Bridge, Ulster Co., N. Y.	Sept. 4, 1906
Farrington, Harold Phillips. Care, Vielé, Blackwell & Buck, 49 Wall St., New York City	April 5, 1910
Faucette, William Dollison. Chf. Clerk to the Pres., Seaboard Air Line Ry., 24 Broad St., New York City	Jan. 6, 1903
Feigel, John Henry. 262 Orange St., Buffalo, N. Y.	Oct. 6, 1908
Felgenhauer, Frank John. Chf. Engr., E. Felgenhauer's Sons (Res., 1439 Dean St.), Brooklyn, N. Y.	May 4, 1909
Ferrier, Joseph James. Office Engr., S. P. Co., 1110 Flood Bldg., San Francisco, Cal.	Dec. 3, 1907
Ferris, Raymond West. Asst. Engr., Ohio State Board of Health, 909 Harrison Bldg., Columbus, Ohio	May 3, 1910
Feustel, Robert Maximilian. Civ. Engr. Insp., Wisconsin R. R. Comm., Madison, Wis.	May 4, 1909
Field, Clesson Herbert. With Schuylkill Bridge Works, Philadelphia, Pa. (Res., 436 Torrey St., Brockton, Mass.)	June 1, 1909
Finch, James Kip. Instr. in Civ. Eng., Columbia Univ., New York City.	June 4, 1907
Finch, Stanley Phister. Instr. in Civ. Eng., Univ. of Texas, 2306 San Antonio St., Austin, Tex.	Oct. 30, 1906
Fleeger, Burtner. With Pittsburg Steel Foundry, Glassport, Pa., 428 Kelly Ave., Wilkinsburg, Pa.	Dec. 6, 1910
Forbes, Francis Bonner. 8 West 56th St., New York City	May 3, 1910
Forsyth, Harold Frederick. Box 223, University Station, Seattle, Wash.	Mar. 2, 1909
Foss, James Calvin, Jr. 1835 Makiki St., Honolulu, Hawaii	April 6, 1909
Foster, Herbert Bismarck. San. Engr., Peoples Water Co., Dept. of Sanitation, Civ. Eng. Bldg., Univ. of California, Berkeley, Cal.	Sept. 3, 1907
Foulds, Roberts Shepherd. Asst. Engr., Phœnix Bridge Co., 216 Morgan St., Phœnixville, Pa.	Feb. 5, 1907
Fowler, Frederick Hall. Asst. Chf. Engr., U. S. Forest Service, 1204 First National Bank Bldg., San Francisco, Cal.	April 3, 1906
Fox, Charles Louis. Asst. Supt., Pennsylvania Water Co., 701 Wood St., Wilkinsburg, Pa.	May 5, 1903
Fox, William Frederick. Asst. to Rd. Engr., Interborough Rapid Transit Co., M. of W. Dept., 108 East 22d St., New York City	April 5, 1910
Frazer, James Stanley. 184 Warburton Ave., Yonkers, N. Y.	Jan. 2, 1906
Frazer, Joseph Heckart. Casilla No. 53, Oruro, Bolivia	Mar. 31, 1908
French, Roger DeLand. Asst. Engr., National Concrete Constr. Co., 54 Board of Trade, Louisville, Ky.	Mar. 6, 1906
Fryer, Henry Le Roy. 131 Mercer St., Trenton, N. J.	April 3, 1906

	Date of Membership
Gaiger, Frank Millard. 66 Brookside Ave., Mt. Vernon, N. Y.	Jan. 7, 1908
Galvin, James Augustine. (Galvin & Clarke), 205 Park Ave., Mechanicsville (Res., 28 Van Derwerken Ave., Cohoes), N. Y.	Sept. 3, 1907
Gard, Hermon Yancy. 1729 South 20th St., St. Joseph, Mo.	Jan. 4, 1910
Gardner, Harry Carter. Instr., Civ. Eng., Univ. of Pennsylvania, 3718 Walnut St., Philadelphia, Pa.	July 1, 1909
Garvey, Victor Hugo. Asst. Engr., Stone & Webster, Sumner, Wash.	Nov. 1, 1910
Garvin, Edgerton Chester. U. S. Engr. Office, Savannah, Ga.	Dec. 3, 1907
Gates, Marshall DeMotte. Asst. Engr., M. of W., Chic. Gt. West. R. R., Des Moines, Iowa	Mar. 31, 1908
Gay, Robert Walter. Prof. of Civ. Eng., Mississippi Agri. and Mech. Coll., Agricultural College, Miss.	Oct. 6, 1903
Gaylord, Clifford Willard. Southwestern Mgr., Keystone Fireproofing Co. of Oklahoma City, 57 Board of Trade, Chicago, Ill.	Oct. 4, 1910
Gaynor, Keyes Christopher. City Engr., Sioux City, Iowa	June 30, 1910
Gearhart, Heber Gossler. 1750 Monadnock Bldg., Chicago, Ill.	Nov. 5, 1907
Germer, Wilhelm Eduard. Care, Mr. Jouett, N. Y. C. & H. R. R. R., 335 Madison Ave., Room 1222½ (Res., 1424 Crotona Park, East, Bronx), New York City	Aug. 31, 1909
Gibble, Isaac Oberholzer. Levelman, M. of W. Dept., Houston Div., Galveston, Harrisburg & San Antonio Ry. Co., San Antonio, Tex.	Nov. 8, 1909
Gill, Harold Earle. 822 President St., Brooklyn, N. Y.	Nov. 1, 1910
Gilland, Thomas Omar. 2029 Ontario St., Tioga, Philadelphia, Pa.	Sept. 4, 1906
Gillelen, Frank. 604 Wright & Callender Bldg., Los Angeles, Cal.	May 1, 1906
Gillespie, Chester Gordon. 1536 Walnut St., Berkeley, Cal.	Sept. 6, 1910
Gillham, Philip Dakin. Mgr., Buffalo Dist. Office, Corrugated Bar Co., Blasdell, N. Y.	Oct. 30, 1906
Gilman, Charles. 1228 Lenox Ave., Plainfield, N. J.	Dec. 6, 1904
Giquel, Rafael Sanchez. Engr. in Chg., Central Highway, Havana Province, Calle 6, No. 18 Vedado, Havana, Cuba	Feb. 4, 1908
Glander, John Henry, Jr. Asst. Engr., with Charles W. Leavitt, Jr., 220 Broadway, New York City	May 3, 1910
Goodman, Harry Minott. Care, Hawaiian Dredging Co., Watertown, Oahu, Hawaii	June 4, 1907
Goodrich, Thomas MacLenathen. Archt. and Cons. Engr. (Goodrich & Goodrich), 520 Lumber Exchange Bldg., Portland, Ore.	Sept. 3, 1907
Gordon, Samuel. Asst. Civ. Engr., U. S. N., Navy Yard, Mare Island, Cal.	Oct. 4, 1910
Gotwals, John Carl. Asst. Engr., Board of Water Supply, New York City, Yorktown Heights, N. Y.	May 5, 1908
Gould, Chester Mason. Asst. Engr., Board of Water Supply, New York City, Cold Spring, N. Y.	April 6, 1909
Gould, John Warren Du Bois. Engr., Gunn, Richards & Co., 43 Exchange Pl. (Res., 269 Lexington Ave.), New York City	Oct. 7, 1902
Graham, Germain Paul. 280 Quail St., Albany, N. Y.	Nov. 8, 1909
Graham, Guy Alexander. Engr. with Snare & Triest Co., Cold Spring, N. Y.	Sept. 6, 1910
Graham, John William. Asst. Engr., 11th Dist., Bureau of Public Works, Cebu, Cebu, Philippine Islands	Oct. 4, 1910
Graham, Leo Daniel. Care, U. S. Reclamation Service, St. Ignatius, Mont.	June 1, 1909
Gram, Ralph Samuel. 218 La Salle St., Room 922, Chicago, Ill.	Mar. 3, 1908
Grannis, James Kidwell. Engr., H. L. Stevens & Co., Fort Worth, Tex.	Sept. 6, 1910
Gray, Harold Farnsworth. 2540 Benvenue Ave., Berkeley, Cal.	Jan. 4, 1910
Greathead, John Francis. Leveler, Barge Canal, 719 North Washington St., Rome, N. Y.	Mar. 3, 1908
Greeley, Samuel Arnold. Care, City Engr., City Hall, Milwaukee, Wis.	Feb. 5, 1907
Green, Arthur Brooks. 10 Lincoln St., Woodfords, Me.	Jan. 31, 1911
Green, Clarence Jasper. 601 Commercial Blk., Portland, Ore.	Sept. 1, 1908
Greene, Lloyd Woolsey. Asst. Engr., N. Y. C. & H. R. R. R.; Res., 132 East 8th St., Oswego, N. Y.	Sept. 1, 1908
Greenlaw, Ralph Weller. Asst. Engr., Board of Water Supply of New York City, Cold Spring, N. Y.	May 3, 1904
Gregson, Alvero Charles. 20 Marlboro Rd., Flushing, N. Y.	May 4, 1909
Griffin, Augustus. Engr. and Supt., Modesto Irrig. Dist., Modesto, Cal.	Oct. 30, 1906
Grindrod, Irvin Sutton. 33d and Clearfield Sts., Philadelphia, Pa.	Feb. 2, 1909
Gross, Charles Aaron. Structural Steel Salesman, Bethlehem Steel Co., 111 Broadway, New York City	Sept. 1, 1908
Gross, Joseph Watson. 2456 Derby St., Berkeley, Cal.	Sept. 1, 1908

Hadley, Homer More. 229 First Ave., North, Seattle, Wash.	April 5, 1910
Halcombe, Norman Marshall. Salmon, Idaho	Sept. 3, 1907
Hale, Herbert Miller. Asst. Engr., Board of Water Supply, New York City, High Falls, N. Y.	Nov. 1, 1904
Hall, Charles Lacey. 2d Lieut., Corps of Engrs., U. S. A., Washington Barracks, Washington, D. C.	June 30, 1910

	Date of Membership
Hall, Joseph Emmett. Pres., J. E. Hall Co., 839 Lemcke Bldg., Indianapolis, Ind	June 30, 1910
Hall, Julius Reed. Chf. Draftsman, Strauss Bascule Bridge Co., 902 Fort Dearborn Bldg., Chicago, Ill	June 6, 1905
Halsey, Milo Clinton. Box 587, Monrovia, Cal	June 30, 1910
Halsey, Wallace Haynes. Bridge Hampton, N. Y	Jan. 7, 1908
Hamilton, Edward Parmelee. With Snare & Triest Co., 143 Liberty St., New York City	April 6, 1909
Hamilton, William Edward. U. S. Insp., Pennington, Ala	Jan. 3, 1911
Hamlin, Horace Parlin. Designing Engr., Raymond Concrete Pile Co., 140 Cedar St., Room 1309, New York City	June 6, 1905
Hammel, Edward Frederic. 2270 Washington Ave., New York City	Feb. 1, 1910
Hammer, Robert Henry. 205 Congress St., Brooklyn, N. Y	Jan. 7, 1902
Hand, Richardson. 84 South St., Wilkes-Barre, Pa	Jan. 3, 1907
Haney, Albert Paul. 3814 Westminster Pl., St. Louis, Mo	Nov. 8, 1909
Hardesty, Shortridge. Asst. to Res. Engr. on Constr. of the Ft. Smith-Van Buren Free Bridge, Van Buren, Ark	Sept. 1, 1908
Harding, Harry Spear. Asst Engr., New York Board of Water Supply, Walden, N. Y	May 31, 1910
Harding, Sidney Twichell. 1557 Hillside Ave., Wichita, Kans	Sept. 5, 1905
Harper, Frederick Clayton. Contr. Engr., Unit Constr. Co., Liggett Bldg., St. Louis, Mo	April 30, 1907
Harrington, Arthur William. Asst. Engr., L. B. Cleveland, 416 Stone St., Watertown, N. Y	Dec. 6, 1910
Harrison, Russell Edwin. Res. Engr. in Chg. of Constr., Filtration Plant, 365 So. Union St., Grand Rapids, Mich	Oct. 30, 1906
Harrod, Tom Hind Hudson. Ithaca, Mich	Feb. 1, 1910
Harvey, Michael Smith. Auburn, Ala	April 30, 1907
Harwi, Solomon Jacob. City Engr., Bayonne, N. J	Dec. 4, 1889
Haselton, Gage. Asst. Engr., S. P. Co., 247 Stout St., Portland, Ore	May 3, 1904
Hastings, Hudson Bridge. Care, Jos. T. Ryerson & Son, 16th and Rockwell Sts., Chicago, Ill	Oct. 5, 1909
Hatch, Everett Hamilton. 142 Hugo St., San Francisco, Cal	Nov. 5, 1907
Hatch, Frederick Nathaniel. Asst. Engr. with Westinghouse, Church, Kerr & Co., 10 Bridge St., New York City	June 4, 1907
Hathaway, Clifford Murray. Draftsman, State Board of Public Roads, 50 Park St., Providence, R. I	Sept. 1, 1908
Hawley, Charles Burridge. Ishpeming, Mich	May 4, 1909
Hayes, Ferdinand Eugene, Jr. With F. E. Hayes, Jr., & Co., 900 Lincoln Bldg., Louisville, Ky	Feb. 4, 1908
Hayman, Edgar Thomas. Road Engr. of Anne Arundel County, Box 235, Annapolis, Md	Aug. 31, 1909
Haywood, Charles Ellsworth. Asst. Engr., Elec. Traction Dept., P. R. R., Pennsylvania Station, 7th Ave. and 32d St., New York City	Nov. 8, 1909
Hazen, Ralph William. Whitefield, N. H	Nov. 30, 1909
Hazen, Richard. With Hazen & Whipple, Cons. Engrs., 103 Park Ave., New York City	Nov. 8, 1909
Hedden, Everett Burr. Asst. Engr., Reading, Pa	Oct. 2, 1906
Heilbronner, Leon Cohen. 238 Union St., Schenectady, N. Y	Mar. 2, 1909
Heiser, Alfred Brackenridge. Draftsman, Turner Constr. Co., 11 Broadway, New York City (Res., 159 Twenty-third St., Brooklyn, N. Y.)	Nov. 1, 1910
Heiser, William Joseph. Designer and Estimator, National Bridge Works, Long Island City, N. Y	Nov. 1, 1910
Helling, Harry Albertus. Y. M. C. A. Bldg., Poughkeepsie, N. Y	Jan. 3, 1911
Hemphill, William Lind. Abbeville, S. C	Oct. 1, 1907
Henderson, John Taylor. Acting Mgr., Big Lost River Irrig. Co., Arco, Idaho	Nov. 1, 1910
Henes, Harry William. Mech. Engr. with A. Bolter's Sons, 84 La Salle St., Room 612 (Res., 2573 N. Clark St.), Chicago, Ill	May 31, 1910
Henley, Robert Dwiggins Monteith. Bldg. Insp., Care, C. F. W. Felt, Chf. Engr., A., T. & S. F. Ry. Co., Topeka, Kans	Sept. 3, 1901
Henry, Smith Tompkins. Associate Editor, *Engineering Record,* 590 Old Colony Bldg., Chicago, Ill	Sept. 5, 1905
Hess, John Strider. Oroville, Cal	Oct. 5, 1909
Hickok, Clifton Ewing. 1040 E. Main St., Portland, Ore	Dec. 6, 1910
Hilder, Frazer Croswell. Topographical Draftsman, Office of Indian Affairs, Washington, D. C	Sept. 6, 1904
Hines, Homer Estle. Engr., M. of W., The Virginian Ry. Co., Princeton, Mercer Co., W. Va	May 5, 1908
Hinman, Leroy Race. 714 Ideal Bldg., Denver, Colo	Feb. 5, 1907
Hirsch, John George. With Daniel W. Mead, Cons. Engr., Madison, Wis.	June 30, 1910
Hitt, Rodney. Associate Editor, *Electric Railway Journal,* 239 West 39th St., New York City	Sept. 5, 1905
Hodgman, Burt Bradley. Gen. Supt., National Water Main Cleaning Co., 61 Park Row, New York City	Sept. 5, 1905
Hoeft, George Eliot. 40 Jackson St., New Rochelle, N. Y	Jan. 3, 1911

	Date of Membership
Hogan, John Philip. Asst. Engr., Board of Water Supply, New York City, High Falls, N. Y.	Dec. 6, 1904
Hohl, Leonard Louis. 612 Marvin Bldg., San Francisco, Cal.	Sept. 4, 1906
Hoisington, Henry Martyn. Care, Anglo-Chinese School, Singapore, Straits Settlements	Feb. 4, 1908
Holbrook, Arthur Raymond. Asst. Engr. Designer, Board of Water Supply of New York City, New Paltz, N. Y.	April 2, 1907
Holland, Howard Kingsbury. Asst. Engr. with Gardner S. Williams, 207 New Eng. Bldg., Ann Arbor, Mich.	June 1, 1909
Holloway, Arthur Power. La Belle Iron Works, Steubenville, Ohio.	Oct. 5, 1909
Holloway, Roger Tifft. 1170 Broadway, New York City	May 31, 1910
Holmes, Robert Leslie. Asst. Engr., Tex. & Pac. Ry. Co., Dallas, Tex.	Oct. 1, 1907
Holmes, Thomas Hughes. Steel Insp., C. & N. W. Ry., 215 Jackson Boulevard, Room 804, Chicago, Ill.	Jan. 4, 1910
Hopper, John Jacob. Civ. Engr. and Contr., 215 West 125th St., New York City	May 5, 1886
Hopson, Edward Harold. Asst. Engr., Board of Water Supply, New Paltz, N. Y.	May 1, 1906
Horner, Wesley Winans. Engr. of Constr., Sewer Dept., St. Louis, Mo.	Sept. 1, 1908
Horrigan, William James. Civ. Engr. and Pres., Horrigan Contr. Co., 507 Ford Bldg., Wilmington, Del.	June 1, 1909
Horton, John William. Asst. Engr., Central California Traction Co., 801 Twenty-fourth St., Sacramento, Cal.	Sept. 1, 1908
Howard, Clement John. Eng. Dept., The Texas Co., Houston, Tex.	Sept. 6, 1904
Howe, Clarence Decatur. Dalhousie Univ., Halifax, Nova Scotia	Oct. 5, 1909
Howe, Frank Ray. Engr. and Supt., Queensboro Corporation, 66 Jamaica Ave., Flushing, N. Y.	June 1, 1909
Howes, Cyrus Pierce. Asst. Engr., Mo. Pac. Ry., Title Guarantee Bldg., St. Louis, Mo.	May 4, 1909
Howes, Donald Winthrop. Asst. Engr., Board of Water Supply, New Paltz, N. Y.	April 4, 1905
Howes, Franklin Johnson. 34 Clinton Ave., Rochester, N. Y.	June 1, 1909
Howes, Ralph Holt. 500 Fifth Ave., New York City	Feb. 2, 1904
Howie, Howard Benson Wilberforce. Asst. City Engr., City Engr.'s Office, Chattanooga, Tenn.	Mar. 6, 1906
Howson, George William, Jr. 1809 Fairview St., Berkeley, Cal.	Oct. 5, 1909
Huff, Walter William. Draftsman, Bridge Dept., L. S. & M. S. Ry., 553 East 114th St., Cleveland, Ohio	Nov. 30, 1909
Hughes, William Richard, Jr. Asst. to Mgr. of Erection, McClintic-Marshall Constr. Co., Pittsburg, Pa.	June 1, 1909
Hull, Gordon Burnett Gifford. Rangeworthy, Northfield, Birmingham, England	July 1, 1909
Humphrey, Frederic Learoyd. Junior Engr., U. S. Reclamation Service, Phœnix, Ariz.	June 4, 1907
Hunter, Leroy Littlefield. Asst. Engr., Bureau of Eng., 807 City Hall, Chicago, Ill.	Jan. 5, 1904
Huntsman, Frank C. Div. Engr., C., B. & Q. R. R., Alliance, Nebr.	Sept. 5, 1905
Hurdle, Reginald Truman. Surv. for Dawson County, Glendive, Mont.	Oct. 1, 1907
Hutchings, John Bacon, Jr. Archt., 809 Columbia Bldg., Louisville, Ky.	Sept 6, 1904
Hutchins, Harry Crocker. Designer, Public Service Comm., 51 Chambers St., Room 207, New York City	Mar. 1, 1910
Hutchins, Roland Ellis. 315 Brown St., Iowa City, Iowa	Nov. 1, 1910
Hyde, Edward Wyllys, Jr. Room 404, McKinnon Bldg., Toronto, Ont., Canada	Sept. 4, 1906
Irvin, Charles Richard. (Irvin & Witherow), 212 Keystone Bldg., Pittsburg, Pa.	Sept. 6, 1910
Irwin, Orlando William. Asst. Chf. Draftsman, L. S. & M. S. Ry., Bridge Dept., Cleveland, Ohio	Sept. 4, 1906
Jabelonsky, Carl Hugo. Cons. Engr. and Archt., 439 Peyton Bldg., Spokane, Wash.	Sept. 1, 1903
Jacobosky, Gilbert Garfield. Cons. Engr., 116 Second National Bank Bldg., Wilkes-Barre, Pa.	Nov. 5, 1907
Jacobs, Julius Lilien. Supt., Houston Office, James Stewart & Co., Contrs., Houston, Tex.	Sept. 1, 1908
Jarvis, Clarence Sylvester. Civ. Engr., Provo Reservoir Co., Provo, Utah.	Sept. 4, 1906
Jerrard, Leigh Patterson. Engr.'s Office, Wisconsin R. R. Comm., Madison, Wis.	Oct. 5, 1909
Johnson, David Clayton. Asst. Engr., H. de B. Parsons, 22 William St., New York City (Res., 245 Hewes St., Brooklyn, N. Y.)	Sept. 1, 1908
Johnson, Granville. 489 Walnut Ave., Jamaica Plain, Mass.	Mar. 5, 1907
Johnston, Andrew Crawford. Civ. Engr. with F. W. Bird & Son, East Walpole, Mass.	Sept. 1, 1908

	Date of Membership
Jones, Benjamin Earl. Helena, Mont	April 6, 1909
Jones, George Morton. Asst. Chf. Engr., Ga. & Fla. Ry., P. O. Box 236, Augusta, Ga	Sept. 3, 1907
Jones, Grandville Reynard. Chf. Chemist and Asst. Supt., Filtration Plant, Washington, D. C	Jan. 7, 1908
Jones, Irving Paul. Georgetown, Del	Mar. 5, 1907
Jones, Pusey. Structural Draftsman, Millbrook Co., 65 Beaver St., New York City	Mar. 6, 1906
Jones, Ralph Henry. 653 West 81st St., Seattle, Wash	Jan. 4, 1910
Jordan, Myron Kendall. With H. S. Crocker, Cons. Engr., 523 East 18th St., Denver, Colo	Mar. 1, 1910
Joslin, Harold Vincent. Asst. Engr., Dept. of Water, in Chg., Surveys (Res., 15 Stratford Apt.), Norfolk, Va	April 6, 1909
Jouine, Georges Pierre Ferdinand. U. S. Junior Engr., Box 404, Vicksburg, Miss	Oct. 6, 1908
Kahn, Gustave Edmund. Chf. Engr., Sterling Eng. & Constr. Co.; Chf. Engr., National Eng. & Constr. Co., Caswell Blk., Milwaukee, Wis	Sept. 6, 1904
Karnopp, Edwin Benjamin. Div. Engr., Madeira-Mamoré Ry., Box 304, Manãos, Brazil	Jan. 3, 1907
Kellersberger, Arnold Charles. Mech. and Civ. Engr., Room 20, Dundee Bldg., Fort Worth, Tex	Oct. 6, 1908
Kennedy, Thomas Patrick Berchmans. Pres. and Treas., Kennedy Constr. Co., 534 Broadway (Res., 138 Washington Ave.), Albany, N. Y.	May 5, 1908
Kesner, Henry James. Instr. in Civ. Eng., Univ. of California, Care, Faculty Club, Berkeley, Cal	Dec. 6, 1910
Kienle, John Aspin. Chf. Engr., Water Dept. (Res., 829 Jackson St.), Wilmington, Del	April 3, 1906
Kilkenny, Tobias Dillon. 930 Pine St., San Francisco, Cal	Oct. 6, 1908
King, Arthur Caswell. Asst. Engr., Water Dept. (Res., 43 Jefferson Ave.), Springfield, Mass	Sept. 4, 1906
King, Edmund Geddes. With Charles F. King & Co., Contrs., 411 Land Title Bldg., Philadelphia (Res., 914 Mahantango St., Pottsville), Pa.	Nov. 8, 1909
King, Eric Ture. Asst. Engr., Board of Water Supply of New York City, Cornwall-on-Hudson, N. Y	Feb. 5, 1907
Kingsley, George. Civ. Engr. and Supt., Constr., U. S. Q. M. D., Sparta, Wis	June 2, 1908
Kinney, William Morton. Asst. Inspecting Engr., Universal Portland Cement Co., 522 Frick Bldg., Pittsburg, Pa	Sept. 6, 1910
Kirkwood, Howard Camberne. Asst. Engr., Penn. T. & T. R. R. Co., Pennsylvania Station (Res., 530 West 153d St.), New York City	Feb. 4, 1908
Kittredge, Frank Alvah. Engr., State Road, Lyle, Wash	Mar. 1, 1910
Knight, Walter Joseph. Engr. for the Gilsonite Constr. Co., 720 Wainwright Bldg., St. Louis, Mo	May 5, 1908
Knutson, George Henry. Draftsman with Gardner S. Williams, 207 New Eng. Bldg., Ann Arbor, Mich	Aug. 31, 1909
Koenig, Louis. Dept. of Docks and Ferries, Pier A, N. R., New York City.	Jan. 7, 1908
Kohn, Arthur Hirsh. 21 North Lime St., Lancaster, Pa	Oct. 2, 1906
Krieger, Albert August. 1141 Cherokee Rd., Louisville, Ky	June 1, 1909
Kriegsman, Eugen Frederick. Asst. Engr., Office of City Engr., San Francisco, Cal	May 5, 1908
Lake, Orloff. 2032 State Ave., New Orleans, La	Dec. 1, 1908
Lapham, John Raymond. West Medway, Mass	Nov. 8, 1909
Larimer, Robert Sherman. Wendell, Idaho	June 1, 1909
Leach, Thomas. 87 Mansfield St., Montreal, Que., Canada	June 30, 1910
Learned, Albert Preisach. Instrumentman on Constr., Cherryvale, Oklahoma & Texas Ry., Nowata, Okla	Dec. 6, 1910
Lee, Charles Hamilton. Asst. Engr., Los Angeles Aqueduct, Independence, Cal	Jan. 2, 1906
Leeds, Charles Tileston. 1st Lieut., Corps of Engrs., U. S. A., 723 Central Bldg., Los Angeles, Cal	Jan. 3, 1907
Leete, Robert Burt. Draftsman, Canadian Bridge Co., Walkerville, Ont., Canada; Res., 641 Cass Ave., Detroit, Mich	Jan. 3, 1911
Lemcke, Karl Wolfgang. Shop. Insp., Am. Bridge Co., Ambridge, Pa.	June 1, 1909
Leonard, Edward Philip. Care, The Sperry Eng. Co., 82 Church St., New Haven, Conn	May 3, 1910
Leonard, Oliver Yeaton. Draftsman, Irrig. Service, Patillas, Porto Rico.	Nov. 8, 1909
Letton, Harry Pike. 1919 D St., Lincoln, Nebr	Feb. 1, 1910
Lewis, Chester Brooks. Civ. Engr. for C. W. Humphrey, 618 Rookery Bldg., Chicago, Ill	Nov. 5, 1907
Lewis, Wilfred. Care, MacArthur Concrete Pile & Foundation Co., Seattle, Wash	Dec. 3, 1907

	Date of Membership
Lichtner, William Otto. Asst. to Sanford E. Thompson, Newton Highlands, Mass	Aug. 31, 1909
Lillich, Joseph Thomas. With New York Telephone Co., 14 West Seneca St., Buffalo, N. Y	Nov. 3, 1903
Lilly, Ridgely Casey. U. S. Junior Engr., Third Dist., Mississippi River Comm., Box 404, Vicksburg, Miss	Oct. 5, 1909
Lincoln, Edward Lewis. Asst. Engr., Board of Water Supply, White Plains, N. Y	May 3, 1910
Lindsay, Richard Lee. Gen. Contr., Municipal Work, 1111 Henry St., Roanoke, Va	Sept. 4, 1906
Lindsley, Thayer. Telluride, Colo	Jan. 3, 1905
Lint, Johannes Adrianus de. District-Inspecteur der Spoorwegdiensten, Oorsprongpark 3, Utrecht, The Netherlands	Sept. 5, 1905
Lisman, Oliver Cromwell. Care, Constr. Dept., Alabama, Tennessee & Northern R. R. Co., York, Ala	Jan. 7, 1908
Littlefield, Emmett. 60 Maple Ave., Troy, N. Y	Feb. 5, 1907
Loughran, Harold Scott. 14 Lawton St., New Rochelle, N. Y	Jan. 2, 1906
Loughran, James Francis. County Supt. of Highways, Ulster Co., Court House, Kingston, N. Y	Feb. 4, 1908
Lowry, John, Jr. Contr. and Builder, 160 Fifth Ave., New York City	Feb. 4, 1908
Lubarsky, Louis Henry. 60 Beaver St., New York City	Feb. 5, 1907
Lundgren, Emil Leonard. Project Engr., Ambalangan Dalin Project, Bureau of Public Works, Manila, Philippine Islands	Feb. 4. 1908
Lydston, Walter Edward. 38 Houston Ave., Mattapan Station, Boston, Mass	April 4, 1905
Lyerly, Charles Abner, Jr. 501 Oak St., Chattanooga, Tenn	Feb. 1, 1910
Lynch, Alexander Sydney. U. S. Junior Engr., U. S. Engr. Sub-Office, 42 Church St., New Haven, Conn	Dec. 6, 1910
Lynch, Edwin Lewis. Third Asst. Engr., Dept., Public Works, 47 Congress St., Portland, Me	Feb. 5, 1907
Lynde, Clifford. Asst. Engr., Board of Water Supply, City of New York, Walden, N. Y	Dec. 1, 1908
Lynn, Henry Hudson Edwin. 116 Nassau St., Room 901, New York City.	May 5, 1908

MacIlvaine, Francis Shippen. P. T. & T. R. R., 7th Ave. and 32d St., New York City	Mar. 3, 1908
Mack, George Horace. Dows, Wright Co., Iowa	Sept. 6, 1910
Mackall, John Nathaniel. Chf. Draftsman, State Roads Comm. of Maryland, Baltimore, Md	Aug. 31, 1909
Macklem, Norris Raymond. Manila, Philippine Islands	April 2, 1907
McCampbell, Alfred Kessinger. U. S. Post Office, Shanghai, China	Nov. 30, 1909
McCandliss, Wallace Highland. Care, Spanish American Iron Co., Felton, Oriente, Cuba	Jan. 7, 1908
McClave, Stephen Wood, Jr. With McClave & McClave, Borough Hall, Cliffside Park, N. J	Jan. 3, 1907
McClure, Harry Clifford. Asst. Engr., Dept. of Architecture, Board of Education, Y. M. C. A., Toledo, Ohio	Mar. 1, 1910
McClure, Hunter. Instr., Cornell Univ., Hill Crest, Ithaca, N. Y	Jan. 4, 1910
McCrory, Sol. 518 Sixth St., Charleston, Ill	Oct. 6, 1903
McCrory, Thomas George. Asst. Chf. Engr., International Contract Co., 501 Central Bldg., Seattle, Wash	Dec. 1, 1908
McDaniel, George Glenn. U. S. Engr. Office, Room 665 Monadnock Bldg., San Francisco, Cal	Mar. 5, 1907
McKinney, Francis William. Care, Clara Consolidated Gold & Copper Min. Co., 512 Bradbury Bldg., Los Angeles, Cal	Mar. 31, 1908
McMullen, Ray Webb. 149 Broadway, New York City	June 30, 1910
McWethy, LeRoy. 1262 Flood Bldg., San Francisco, Cal	Jan. 4, 1910
Maglott, George Frederick. 3932 Lake Ave., Chicago, Ill	Oct. 4, 1910
Mahone, William, Jr. Box 213, Newbern, N. C	April 5, 1910
Malcomson, Alfred Sidney. Municipal and Civ. Engr. (Smith & Malcomson), 37 Railroad Ave., Freeport, N. Y	Mar. 3, 1908
Malmros, Nils Lorentz Alfred. 111 First St., Yonkers, N. Y	Jan. 31, 1911
Malony, Walden Le Roy. Asst. to City Engr., Bridge Dept., P. O. Box 1078, Spokane, Wash	Aug. 31, 1909
Malsbury, Omer Evert. Junior Engr., P. R. R., Ancon, Canal Zone, Panama	Feb. 5, 1907
Manzanilla y Carbonell, José Justo. H, y 13, Vedado, Havana, Cuba	June 30, 1910
Marsh, Charles Reed. Civ. Engr. and Supt. of Constr., Quartermaster's Dept., U. S. A., 263 Summer St., Boston, Mass	June 30, 1910
Marsh, Emmett Lincoln. Asst. Engr., S. P. R. R. Co., East Auburn, Cal.	Mar. 5, 1907
Marston, Frank Alwyn. Asst. Engr. with Metcalf & Eddy, 14 Beacon St., Boston, Mass	Mar. 1, 1910
Martinez, Rolando Arnoldo. Campanario 160, Havana, Cuba	Dec. 1, 1908

	Date of Membership
Maxwell, Donald Hebard. Asst. Engr., Alvord & Burdick, 1212 Hartford Bldg., Chicago, Ill	April 5, 1910
Mayell, Albert Jefferson. Asst. Engr., Public Service Comm. for the First Dist., 154 Nassau St. (Res., 322 East 198th St.), New York City.	Mar. 1, 1904
Maynard, Henry Warner. Brown Hoisting Machinery Co., Cleveland, Ohio.	Dec. 3, 1907
Mehren, Edward John. Associate Editor, *Engineering Record,* 239 West 39th St., New York City	Oct. 30, 1906
Mendenhall, Herbert Drummond. Lakeland, Fla	Sept. 4, 1906
Merrill, Robert Hall. Asst. Engr., Barge Canal Office, Medina, N. Y	May 3, 1904
Merriman, Richard Mansfield. With Hering & Fuller, Cons. and San. Engrs., 170 Broadway, New York City (Res., Central Valley, N. Y.).	Jan. 3, 1907
Merritt, Charles Edward. 351 Genesee St., Utica, N. Y	Jan. 4, 1910
Messer, Hope Richard. San. Engr., Dept. of Health of Virginia, 1110 Capitol St., Richmond, Va	Oct. 4, 1910
Mieth, Richard Elam. Contr. Engr., Standard Bridge Co., Omaha, Nebr.	May 1, 1906
Millard, Curtiss. Engr., M. of W., Chic. Gt. West. R. R. Co., Des Moines, Iowa	April 3, 1889
Millard, William John. Kinshasa, Congo Belge, West Africa	Nov. 30, 1909
Miller, Fritz. Instrumentman, Utah Copper Co., Utah Copper Mine Office, Bingham Canyon, Utah	June 4, 1907
Miller, Harold Edmund. Chf. Draftsman, Rhode Island State Board of Public Roads, 110 Dexter St., Providence, R. I	Oct. 1, 1907
Miller, Henry Lanark. Insp. de Obras, Departmento de Obras Publicas, Casilla Correo 117, Mendoza, Argentine Republic	June 4, 1907
Miller, Hugh. Prof. of Civ. Eng., Clarkson School of Technology, 1 Chestnut St., Potsdam, N. Y	Nov. 30, 1909
Mills, Adelbert Philo. Asst. Prof. of Civ. Eng., Coll. of Civ. Eng., Cornell Univ., Ithaca, N. Y	Sept. 3, 1907
Mischke, Alexander. Engr. of Ways of Communication; Prin. Asst. Chf. Engr., Warsaw Govt., Terminal Ry. Constr., 16 Jouravlinaya, Warsaw, Russia	Oct. 5, 1909
Mitchell, William Washington. Res. Engr., Big Blackfoot Ry. Co., Bonner, Mont	April 2, 1907
Montero, Julio Daniel. Enramadas alto No. 34 (altos), Santiago de Cuba, Cuba	Oct. 1, 1907
Moore, James Gates. Care, Piedmont Traction Co., Charlotte, N. C	Aug. 31, 1909
Moore, Stanley Wallace. Asst. Mgr., Manila Constr. Co., Box 590, Manila, Philippine Islands	July 1, 1909
Moore, Walter Smyth. Draftsman, Chf. Engr.'s Office, L. & N. R. R., Louisville, Ky	Dec. 6, 1910
Moran, Robert Breck. 661 Waverley St., Palo Alto, Cal	Sept. 1, 1908
Morrison, Christopher George. Asst. Engr., Dist. No. 8, Bureau of Public Works, Albay, Albay, Philippine Islands	Oct. 5, 1909
Moser, Albert Leo Brecht. Care, E. A. Moser, Cripple Creek, Colo	Jan. 3, 1907
Mott, Thomas Clayton. Insp., Board of Water Supply, City of New York, High Falls, N. Y	May 3, 1910
Moulton, Oren McKenney. P. O. Box 348, Newark, N. J	April 2, 1907
Muchemore, Harrie Langdon. Prin. Civilian Asst. on Constr. of Dry Dock No. 4, New York Navy Yard; Res., 265 Orchard St., Elizabeth, N. J.	Mar. 1, 1910
Muir, Alexander Wicliffe. 156 Main St., Newton, N. J	Jan. 3, 1911
Munkelt, Frederick Hermann. 668 East 13th St., Brooklyn, N. Y	April 5, 1910
Murphy, James Francis. Asst. Engr., Board of Water Supply, Brown Station, Ulster Co., N. Y	May 31, 1910
Nagel, Theodore. Supt. of Works, National Metal Moulding Co., Economy, Pa., Wilmar Apartments, Craig and Forbes Sts., Pittsburg, Pa	Dec. 6, 1910
Nawn, Hugh. 43 Brunswick St., Roxbury, Mass	Jan. 31, 1911
Neal, Clarence Adkins. Secy., Union Bridge & Constr. Co., 903 Sharp Bldg., Kansas City, Mo	Dec. 6, 1904
Nelson, Jabez Curry. Engr. with Ford, Bacon & Davis, 115 Broadway, New York City	Oct. 1, 1907
Neuhardt, Edwin. Engr. Insp., Wharf Constr., Cent. of Ga. Ry., Ocean Steamship Co., Box 321, Savannah, Ga	Nov. 8, 1909
Newton, George Cheney. Engr., Newton Eng. Co., 1211 Majestic Bldg., Milwaukee, Wis	Feb. 4, 1908
Nichol, Henry Schell. Asst. Engr., Canadian Collieries, Ltd., Victoria, B. C., Canada	Jan. 2, 1906
Nichols, John Robert. Instr. in Civ. Eng., Harvard Univ., 82 Avon Hill St., Cambridge, Mass	June 1, 1909
Nikirk, Frank Austin. 60 W. Virginia St., San José, Cal	April 2, 1907
Nordwell, Alfred Worcester. 18 Lake Ave., Oakland, Cal	June 1, 1909
Norwood, Edgar Alva. 19 Mason St., Medford Hillside, Mass	Nov. 30, 1909
Noyes, Stephen Henley. Care, Pennsylvania Steel Co., B. and C. Dept., Steelton, Pa	Oct. 1, 1907

	Date of Membership
O'Donnell, Charles Jerome. Asst. Engr., Board of Water Supply of New York City, R. F. D. No. 4, Newburgh, N. Y.	April 5, 1910
Ogier, George Rufus. Engr. and Contr. (Ogier, Silsbee & Ogier), 710 Majestic Bldg., Denver, Colo.	Jan. 4, 1910
Okes, Day Ira. Chf. Engr., Kettle River Co., 218 North 5th St., Minneapolis, Minn.	Mar. 1, 1910
O'Reilly, Francis Sheridan. Engr., Degnon Contr. Co., Sandwich, Mass.	Jan. 4, 1910
Osborn, Kenneth Howard. Asst. Engr., Osborn Eng. Co., Osborn Bldg., Cleveland, Ohio	Oct. 5, 1909
Ottosen, Peter Hill. Lieut., Coast Artillery Corps, U. S. A., Fort Ward, Wash.	Oct. 6, 1908
Overocker, Daniel Willets. Barge Canal Office, Amsterdam, N. Y.	Oct. 4, 1910
Owen, Kenneth Dunham. Montclair, N. J.	Feb. 6, 1906
Pagon, William Watters. With J. E. Greiner, Cons. Engr., Continental Bldg. (Res., 1301 St. Paul St.), Baltimore, Md.	Sept. 3, 1907
Paine, George Hebard. The Continental Signal Co., 46 East Van Buren St., Chicago, Ill.	Nov. 5, 1890
Paret, John Waldo. Care, Stamford & Eastern Ry., Stamford, Tex.	Feb. 1, 1910
Parker, Kingsbury Eastman. 841 Monadnock Bldg., San Francisco, Cal.	May 5, 1908
Parlin, Raymond Washington. Engr. and Contr.; Asst. Engr. with W. S. Johnson, 101 Tremont St., Boston, Mass.	June 30, 1910
Parrigin, Frank Snow. Chf. Engr., Tampa & Jacksonville Ry. Co., Gainesville, Fla.	May 3, 1910
Paterson, Charles Judson. Supt. of Erection, Reinforced Tile Roof Co., Youngstown, Ohio	Feb. 1, 1910
Patterson, Earl. U. S. Reclamation Service, Selden, Dona Ana Co., N. Mex.	April 30, 1907
Patterson, Irving Wooster. Asst. Engr. with A. H. Blanchard, 94 Angell St., Providence, R. I.	Jan. 4, 1910
Paul, Theodore Lochart. Rodman, Providence Div., N. Y., N. H. & H. R. R., Box 86, Sherborn, Mass.	Feb. 1, 1910
Payrow, Harry Gordon. Eng. Dept., Waterbury, Conn.; Address, Box 41, R. F. D. No. 1, Thomaston, Conn.	Feb. 4, 1908
Peck, Charles Franklin. Asst. on Engr. Corps, Penn. Lines West, 352 Cutler St., Allegan, Mich.	April 2, 1907
Peck, John Calvin. Office of the Div. Commercial Engr., New York Telephone Co. (Res., 273 Hamilton St.), Albany, N. Y.	Sept. 1, 1908
Pendleton, David Elliott. Care, H. & T. C. R. R., Ennis, Tex.	Jan. 2, 1906
Perry, John Prince Hazen. Mgr., Contr. Dept., Turner Constr. Co., 11 Broadway, New York City	Nov. 1, 1904
Perry, Lynn Elwood. Secy. and Engr., Houston, Perry & Co., Seaford, Del.; Address, Salisbury, Md.	Sept. 1, 1908
Peterson, Garfield Christian. Care, Cuba Eastern R. R., Guantanamo, Cuba	Oct. 2, 1906
Phillips, Clifford French. Care, Gasconade Central Telephone Co., Hermann, Mo.	Nov. 30, 1909
Pierce, Paul Leon. 909 East 9th St., Chattanooga, Tenn.	Jan. 7, 1908
Pill, Leon Morley. Asst. to City Engr., 1225 Eleventh Ave., South, Birmingham, Ala.	Aug. 31, 1909
Pillet, Frederick Fischer. First Asst. Engr., Board of Public Works, Mobile, Ala.	June 2, 1903
Poole, Ruble Isaac. Instr., Dept. of Civ. Eng., The North Carolina Coll. of Agriculture and Mechanic Arts, Lock Box 128, West Raleigh, N. C.	Dec. 6, 1910
Poore, Herbert Carleton. 73 Central Ave., Wollaston, Mass.	Jan. 31, 1911
Porter, Harry Franklin. The Harris, 13th and Broadway, Kansas City, Mo.	Nov. 5, 1907
Porter, John Endicott. Asst. Engr., Office of Engr. of Structures, N. Y. C. & H. R. R. R., 7th Floor, Grand Central Palace, New York City (Res., 6 Ashburton Pl., Yonkers, N. Y.)	Sept. 1, 1903
Potter, Edwin James. Y. M. C. A. Bldg., New Bedford, Mass.	Oct. 1, 1907
Powell, William Jenner. Asst. Engr., City Engr.'s Office, Dallas, Tex.	Jan. 2, 1906
Price, Donald Douglas. Asst. State Engr. of Nebraska, State House, Lincoln, Nebr.	Sept. 6, 1910
Price, William Edmund. Engr., Layton, Smith & Hawk, Archts., Majestic Bldg., Oklahoma, Okla.	April 5, 1910
Pruett, Grover Cleveland. City Engr., Miles City, Mont.	Mar. 2, 1909
Querbach, Earl. Draftsman, Am. Bridge Co., Ambridge (Res., 510 Blackburn Ave., Sewickley), Pa.	Dec. 4, 1906
Rackle, Oscar William. 94 Angell St., East Side Station, Providence, R. I.	Sept. 4, 1906
Ramsdell, Robert Leroy. Address unknown	Oct. 6, 1908

JUNIORS R-S

	Date of Membership
Ramser, Charles Ernest. Instr. in Civ. Eng., Brooklyn Polytechnic Inst., 207 Congress St., Brooklyn, N. Y.	Mar. 1, 1910
Raschbacher, Harry George. 110 La Salle St., Suite 525, Chicago, Ill.	May 2, 1905
Rathbun, John Charles. Chf. Draftsman, State Highway Commr.'s Office, Olympia, Wash.	Oct. 6, 1908
Read, Bill. 167 Washington Ave., San José, Cal.	Nov. 8, 1909
Reed, Carl Sweetland. Western Representative, Am. Locomotive Co., Railway Exchange Bldg., Chicago, Ill.	Mar. 31, 1908
Reed, Frank Edward. With State Dept. of Highways, 63 Canvass St., Cohoes, N. Y.	April 6, 1909
Reed, Ralph John. 1012 Security Bldg., Los Angeles (Res., Whittier), Cal.	Sept. 1, 1908
Reese, George Washington. U. S. Junior Engr., P. O. Box 12, Poughkeepsie, N. Y.	May 31, 1910
Regester, Henry Slicer, Jr. Asst. Engr., Sewerage Comm., 908 American Bldg., Baltimore, Md.	Jan. 7, 1908
Reimann-Hansen, Robert Louis. Draftsman, B. & O. R. R., 3637 Park Heights Ave., Baltimore, Md.	Oct. 3, 1905
Rennell, Henry Hurd. United Rys. of Havana, Havana, Cuba	Mar. 3, 1908
Reynolds, Leon Benedict. Care, Burns & McDonnell, Scarritt Bldg., Kansas City, Mo.	Oct. 4, 1910
Reynolds, Robert Albert. 170 Blain Ave., Detroit, Mich.	May 5, 1908
Rhodes, Glenn Vernon. Junior Asst. Engr., Board of Public Works, 152 Twelfth Ave., San Francisco, Cal.	May 3, 1910
Rice, Rowland Grenville. 192 Summer St., Stamford, Conn.	Mar. 5, 1907
Rich, Wilder Meloy. U. S. Engr. Office, Sault Ste. Marie, Mich.	Sept. 3, 1907
Richards, Arthur. Care, Isthmian Canal Comm., Dept. of Constr. and Eng., Atlantic Div., Gatun, Canal Zone, Panama	Jan. 4, 1910
Richardson, Jeremiah Daniels. 60 Vine St., Corona, N. Y.	Jan. 7, 1908
Riegel, Ross Milton. Asst. Engr., Designing Div., Board of Water Supply, 165 Broadway, New York City	Mar. 5, 1907
Rindsfoos, Charles Siesel. With The Foundation Co., 115 Broadway, New York City	April 2, 1907
Roberg, Ralph Mason. Supt. of Constr., H. L. Stevens & Co., Kansas City, Mo.	Sept. 6, 1910
Roberts, Harold Whitney. With Rapid Transit Subway Constr. Co., 165 Broadway (Res., 625 West 138th St.), New York City	Oct. 5, 1909
Roberts, Richard Francis. Draftsman, Bridge Dept., N. Y., N. H. & H. R. R., Room 314, Railroad Bldg., New Haven, Conn.	May 31, 1910
Roberts, Vincent. 1123 Broadway, New York City	Mar. 6, 1906
Robinson, Ward Reid. Examiner of Efficiency (Eng.), Civil Service Comm., 5531 Monroe Ave., Chicago, Ill.	April 2, 1907
Rogers, Thomas Farwell. 421 Monroe St., Monterey, Cal.	Mar. 5, 1907
Rollins, Andrew Peach. Eagle Lake, Tex.	May 4, 1909
Rome, Lyford. 334 Schermerhorn St., Brooklyn, N. Y.	Nov. 1, 1910
Rommel, William Gustave. Asst. Engr. with T. C. Hatton, 233 Broome St., Wilmington, Del.	Oct. 2, 1906
Rossell, Paul Francis. 1201 North Clayton St., Wilmington, Del.	Mar. 2, 1909
Rowe, Wilfred Lincoln. Sunnyside, Wash.	Mar. 31, 1908
Russell, Alexander Allen MacVicar. 349 Frederick St., San Francisco, Cal.	May 5, 1908
Russell, Alexander Stuart. Petersburg, Mich.	Oct. 6, 1908
Ryan, Richard R. Sault Ste. Marie, Mich.	Dec. 3, 1907
Sackett, Arthur Johnson. Chf. of Party, P. T. & T. R. R. Co., 345 East 33d St., New York City	Mar. 1, 1904
St. John, Walter Sherman. 341 Edgecombe Ave., New York City	Sept. 6, 1910
Sanger, Walter Max. Draftsman, A. L. Harris, 418 Fleming Bldg., Phœnix, Ariz.	May 5, 1908
Sawyer, James Herbert. Address unknown	Mar. 5, 1907
Saxe, Van Rensselaer Powell. Asst. Engr. for Standard Concrete Steel Co., 415 East 31st St. (Res., 144 East 22d St.), New York City	Feb. 4, 1908
Schlickeisen, Albert August. Address unknown	Dec. 3, 1907
Schmid, Francis Rauch. Designing Draftsman, N. Y. C. & H. R. R. R., 30 Wall St., Bethlehem, Pa.	Oct. 6, 1903
Schmid, Robert John. Carlyle Hotel, Spokane, Wash.	Feb. 2, 1909
Schmitt, Jacob. Asst. Engr., Bureau of Highways, 36 Municipal Bldg., Brooklyn, N. Y.	June 2, 1903
Schobinger, George. Engr. Insp., Board of Superv. Engrs., Chicago Traction, 181 La Salle St., Chicago, Ill.	Oct. 5, 1909
Scholtz, Herman Fred. Asst. Engr., Erickson Const. Co., Dry Dock No. 2, Puget Sound Navy Yard, Bremerton, Wash.	Oct. 30, 1906
Schultz, Charles. Asst. City Engr., Gen. Delivery, Muskogee, Okla.	Nov. 1, 1904
Schumann, Carl Julius. Secy., Moller & Schumann Co., Marcy and Flushing Avenues, Brooklyn, N. Y.	Dec. 2, 1902

	Date of Membership
Schuyler, Montgomery. 4670 Gibbons St., St. Louis, Mo.	Sept. 1, 1908
Scott, James Robinson, Jr. Masonry Insp., Ill. Central R. R. Co., Bridge and Bldg. Dept., 1 Park Row, Room 1000, Chicago, Ill.	Mar. 1, 1910
Scott, Walter Vanderbelt. With Lackawanna Bridge Co. (Res., 1 Johnson Park), Buffalo, N. Y.	Nov. 8, 1909
Searight, George Peter. Instrumentman, N. Y. C. R. R., 23 East 48th St., New York City	Nov. 1, 1910
See, George Corliss. Asst. Engr., Dept., State Engr. and Surv., Troy, N. Y.	Sept. 3, 1907
See, Russell Alva. New Florence, Mo.	Oct. 4, 1910
Seeley, Henry Arthur. 1437 Park Ave., Bridgeport, Conn.	Jan. 4, 1910
Selby, Oscar Ellsworth. Engr. of Bridges and Structures, C., C., C. & St. L. Ry., Cincinnati, Ohio	Mar. 4, 1891
Selmer, William Lee. Hamilton Park, New Brighton, N. Y.	Mar. 31, 1908
Shafer, James Charles Forsythe. Res. Engr. for Truesdell-Fox Co., New York City, Hadlock, Wash.	Oct. 6, 1908
Shankland, Ralph Graham. Supt. of Concrete Constr. for E. C. & R. M. Shankland, 1106 The Rookery Bldg., Chicago, Ill.	Nov. 8, 1909
Shapleigh, Charles Henry. Chf. Engr., River, Rail & Harbor Constr. Co., 739 North State St., Jackson, Miss.	June 30, 1910
Shaw, Walter Farnsby. Care, Barge Canal Office, R. F. D. No. 5, Rome, N. Y.	Jan. 4, 1910
Shelley, Oswald Procter. Engr., The Lilley & Thurston Co., 82 Second St., San Francisco, Cal.	April 5, 1904
Shema, Joseph. Insp. of Bridges, B. & O. R. R., Wheeling, W. Va.	Oct. 3, 1905
Sherman, Arthur Louis. Asst. Engr., Board of Water Supply of New York, Y. M. C. A., White Plains, N. Y.	Jan. 4, 1910
Shoemaker, Harry. Box 252, Fort Edward, N. Y.	Sept. 3, 1907
Sieling, Louis John. Supt. of Constr. for McHarg-Barton Co., Contrs., 165 Broadway, New York City (Res., 539 Linwood St., Brooklyn, N. Y.)	Feb. 1, 1910
Simpson, Charles Randolph. 201 Second St., Huntingdon, Pa.	Feb. 2, 1909
Sims, Harvey Hillyer. Care, Edible Products Co., 160 East 22d St., Bayonne, N. J.	May 4, 1909
Small, Gilbert. 428 Lexington St., Waltham, Mass.	June 1, 1909
Small, James Hampden, Jr. Engr., Ryan-Parker Constr. Co., 165 Broadway, New York City	Mar. 31, 1903
Smith, Charles Horton. County Engr., 16 East Main St., Middletown, N. Y.	June 4, 1890
Smith, Elroy George. 245 West 128th St., New York City	Sept. 1, 1908
Smith, Ford Cushing. Care, Rev. G. H. Smith, Rhinebeck, N. Y.	April 3, 1906
Smith, Francis Marshall. Roadmaster, N. P. Ry., Room 27, Second and King Sts., Seattle, Wash.	Jan. 3, 1907
Smith, Joseph. Asst. Engr., Public Service Comm., 23 Flatbush Ave., Brooklyn, N. Y.	Feb. 2, 1909
Smith, Lewis Ruffner, Jr. Care, Great Northern Ry. Co., Wellington, Wash.	Dec. 6, 1910
Smith, Marion deKalb, Jr. 6 Washington Ave., Chestertown, Md.	Oct. 1, 1901
Smith, Robert Mackinlay. 3 Westbourne Terrace, Kelvinside, Glasgow, Scotland	June 6, 1905
Smith, Shaler Gordon. Care, St. Clair County Gas & Elec. Co., East St. Louis, Ill.	July 1, 1909
Smoyer, Lloyd Isadore. With Post & McCord, 44 East 23d St., New York City	Oct. 4, 1910
Smyth, Arthur Porter. Care, U. S. Reclamation Service, Huntley, Mont.	Jan. 3, 1911
Snyder, Hunter Imboden. Room 6, Baldwin Bldg., Jacksonville, Fla.	Nov. 30, 1909
Soest, Hugo Conrad. Constr. Dept., Interborough Rap. Trans. Co., 32 Park Pl., New York City	May 31, 1910
Soo-Hoo, Peter. 1308 W. Springfield Ave., Urbana, Ill.	Jan. 31, 1911
Spalding, Walter James. Asst. Engr., Pacific Div., Second Dist., Isthmian Canal Comm., Balboa, Canal Zone, Panama	Nov. 1, 1904
Spaulding, Ralph Edgar. (E. N. & R. E. Spaulding, Eng. Contrs.), Suffield, Conn.	May 31, 1910
Speidel, Hugo S. Pres., The David Henry Bldg. Co., Cor., Main and Smith Sts., Paterson, N. J.	Feb. 5, 1890
Sperry, Austin Russell Willard. Asst. Engr., Crocker-Hoffman Land & Water Co., Merced, Cal.	Dec. 6, 1910
Spooner, Charles Willett. Prin. Asst. Engr. to Gardner S. Williams, 205 New Engineering Bldg., Ann Arbor, Mich.	Mar. 2, 1909
Sprague, Edwin Loring, Jr. Asst. Engr., Board of Water Supply, Valhalla, N. Y.	May 31, 1904
Squire, Harry Edwin. Engr. for Erickson Const. Co., 924 Highland Ave., Bremerton, Wash.	Jan. 3, 1907
Stadel, George Henry. Civ. and Landscape Engr., 232 Sound View Ave., Stamford, Conn.	Sept. 6, 1910

	Date of Membership
Stanton, Harry Seel. Junior Engr., U. S. Reclamation Service, Elephant Butte, N. Mex	Oct. 4, 1910
Stanton, Robert Brewster, Jr. Draftsman, The Niles Tool Works Co., 249 North 3d St., Hamilton, Ohio	Mar. 1, 1910
Starr, William H. 3 West 8th St., New York City	April 2, 1884
Steegmuller, Charles Albert Augustine. High Falls, N. Y	Mar. 6, 1906
Steese, James Gordon. 1st Lieut., Corps of Engrs., U. S. A.; Asst. Engr., Chf. Engr.'s Office, Culebra, Canal Zone, Panama	Aug. 31, 1909
Steinman, David Bernard. Instr. in Civ. Eng., Univ. of Idaho, Moscow, Idaho	Mar. 1, 1910
Stephenson, Grant Thomas. Gen. Supt., Mashek Chemical & Iron Co., Wells, Delta Co., Mich	May 5, 1908
Stewart, Charles Sumner. Draftsman, H. B. Sachett Screen & Chute Co., 1805 Warren Ave., Chicago, Ill	Nov. 30, 1909
Stewart, Walter Phelps. U. S. Junior Engr., 1307 Liggett Bldg., St. Louis, Mo	Nov. 8, 1909
Stewart, William James. First Asst. City Engr., Rochester, N. Y	May 7, 1890
Stiles, Albert Irvine. Asst. Engr., Isthmian Canal Comm., Culebra, Canal Zone, Panama	Feb. 6, 1906
Stilson, Charles Edward. With Long Sault Development Co., Box 426, Massena, N. Y	Mar. 1, 1910
Stirling, Vincent Reynolds. Asst. Engr., Moro Province, Zamboanga, Philippine Islands	Oct. 2, 1906
Stone, James Hammond. Care, H. F. D. Burke, Director Gen. of Public Works, Dominican Republic, Santo Domingo, Santo Domingo	Mar. 31, 1908
Stow, Mulford. Insp., New York Board of Water Supply, Box 44, Wallkill, N. Y	Sept. 3, 1907
Strain, Benjamin. Asst. Engr., Cent. N. E. Ry. Co., Maybrook, N. Y	April 5, 1910
Strohl, Richards Merle. Genoa, Ottawa Co., Ohio	May 31, 1910
Strong, Sidney Davis. Junior Engr., U. S. Engr. Office, Sault Ste. Marie, Mich	Nov. 5, 1907
Strout, Gale Stanley. Palo Alto, Cal	Mar. 31, 1908
Sun, Taoyuh Clarance. Asst. Engr. on Kirin & Chang Chung R. R., 15 Peking Rd., Shanghai, China	Oct. 4, 1910
Suttle, Clifford Bradley. 43d and Chester Ave., Philadelphia, Pa	Oct. 30, 1906
Sweeney, John Bernard. 703 East Parkway, McKeesport, Pa	Feb. 4, 1908
Sweesy, Thomas King. Engr. of Constr., San Quentin, Cal.; Address 2520 Cedar St., Berkeley, Cal	Aug. 31, 1909
Sweetland, Harold Anthony. 9 Orchard Ave., Providence, R. I	Oct. 5, 1909
Swensson, Otto Jordan. Insp., Board of Water Supply of New York City, Yorktown Heights, N. Y	Nov. 8, 1909
Swett, Everett Harold. Care, U. S. Reclamation Service, Montrose, Colo.	Oct. 1, 1907
Swett, William Claude. Asst. Engr., Ore. Short Line R. R., P. O. Box 51, Pocatello, Idaho	Nov. 1, 1910
Tappan, Roger. Care, Baring Bros. & Co., Ltd., 8 Bishopsgate St., Within, London, E. C., England	Dec. 3, 1884
Tatum, Robert Lee. U. S. Junior Engr., Box 404, Vicksburg, Miss	Nov. 8, 1909
Taylor, George Blaney. Engr. with Berlin Constr. Co., Berlin (Res., 17 Lenox Pl., New Britain), Conn	May 3, 1910
Taylor, Warren Crosby. Instr. in Civ. Eng., Union Coll., Schenectady, N. Y	Feb. 4, 1908
Teal, Jonathan Ernest. Roadmaster, Mo. Pac. Ry., Monroe, La	June 1, 1909
Tefft, William Wolcott. Care, Kalamazoo Development, Kalamazoo, Mich	Mar. 31, 1908
Teichert, Adolph, Jr. 2401 J St., Sacramento, Cal	July 1, 1909
Terry, Francis Marion. Designing Engr. and Supt. of Constr., H. L. Stevens & Co., Oklahoma, Okla	June 30, 1910
Thayer, Nathaniel Augustine. Structural Steel Engr., 417 West 120th St., New York City	April 5, 1910
Thompson, Gordon Saxton. Asst. in Dept. of Mechanics, Rens. Poly. Inst., 689 Second Ave., Troy, N. Y	Sept. 5, 1905
Thomson, Fred Morton. Lockhart, Tex	Oct. 6, 1908
Thomson, Warren Brown. Asst. Engr., Boston & Albany R. R., The Granit Bldg., Springfield, Mass	Feb. 5, 1907
Tiffany, Nathan Newton. Civ. Engr. and Surv.; Mgr., East Hampton Elec. Light Co., East Hampton, N. Y	June 5, 1906
Tillit, Pedro Ernesto. 4600a Delmar Ave., St. Louis, Mo	Oct. 5, 1908
Tillson, Edwin Delevan. Truell Court, Plainfield, N. J	Mar. 2, 1909
Timberlake, Seth Martin. Asst. Engr., Board of Water Supply of New York, Cornwall-on-Hudson, N. Y	Mar. 1, 1910
Tingley, Francis. With Am. Pipe & Constr. Co., P. O. Box 596, Walden, N. Y	Jan. 3, 1911
Tirrell, Charles Edwards. Care, A. Friedrich & Sons Co., 106 Mill St., Rochester, N. Y	Sept. 4, 1906

	Date of Membership
Todd, Oliver Julian. Chf. Hydrographer on Sierra Water Supply for City of San Francisco, Groveland, Cal	Aug. 31, 1909
Toensfeldt, Hans Carl Thomas. Commr. of School Bldgs., Board of Education, St. Louis, Mo	April 1, 1902
Toll, Asahel Clark. Baldwinsville, N. Y	Mar. 5, 1907
Toll, Roger Wolcott. Denver City Tramway Co., Denver, Colo	Oct. 5, 1909
Tolles, Frank Clifton. With U. S. Engr. Dept., Chesterfield Apartments, Louisville, Ky	May 31, 1910
Toms, Jay William. Corrugated Bar Co., 1410 National Bank of Commerce Bldg., St. Louis, Mo	Nov. 30, 1909
Torralbas, Rafael Joaquin. Insp. for the Sewerage and Paving Contract, Havana, Cuba	Nov. 1, 1910
Towle, Foster. Care, U. S. Reclamation Service, Helena, Mont	Oct. 30, 1906
Tozzer, Arthur Clarence. Supt. of Constr., Turner Constr. Co., 11 Broadway, New York City	April 4, 1905
Trask, Warren Dudley. Care, U. S. Reclamation Service, Fort Shaw, Mont.	Feb. 1, 1910
Trelease, Frank Johnson. Asst. Engr., Corrugated Bar Co., 1518 New Bank of Commerce Bldg., St. Louis, Mo	May 3, 1910
Trowbridge, Alfred Lockwood. Field Engr., Pacific Gas & Elec. Co., 445 Sutter St., San Francisco, Cal	Sept. 3, 1907
Turner, Charles Russell. 456 Salem St., Malden, Mass	Oct. 3, 1905
Turner, Le Baron. Engr., U. S. Wind Engine & Pump Co., Batavia, Ill.	Sept. 5, 1905
Tutherly, George Cotton. Claremont, N. H	April 30, 1907
Tyler, Richard Gaines. Instr. in Civ. Eng., Univ. of Texas, 1510 West Ave., Austin, Tex	Oct. 6, 1908
Tyler, William Rogers. With Ruggles-Robinson Co., Contrs., 45 East 42d St., New York City	Feb. 2, 1909
Upton, Joseph. 109 Main St., Flushing, N. Y	Nov. 1, 1910
Vandervoort, Benjamin Franklin. Asst. Engr., State Water Supply Comm., Albany, N. Y	Mar. 2, 1909
Van Horne, John Russell. 165 Broadway, Room 2611, New York City.	Nov. 5, 1907
Van Vleck, James Brackett. 961 East 22d St., Brooklyn, N. Y	May 5, 1908
Van Zile, Harry Lee. Pres., Franklin Boiler Works Co., 39 Cortlandt St., New York City	Jan. 6, 1886
Veatch, Nathan Thomas, Jr. Asst. Engr., State Board of Health, 1043 Indiana St., Lawrence, Kans	Nov. 8, 1909
Vensano, Harry Chittenden. Civ. Engr., Pac. Gas & Elec. Co., 445 Sutter St., San Francisco, Cal	June 4, 1907
Villa, Miguel. Asst. Engr., Dept. of Public Works, Arsenal, Havana, Cuba.	Oct. 6, 1908
Vogel, John Leonard. 61 Belmont Ave., Jersey City, N. J	Nov. 5, 1907
Volck, Adalbert George. Care, The Red Hook Light & Power Co., R. F. D. No. 2, Bingham Mills, Germantown, N. Y	Dec. 1, 1908
von Blücher, Carl Felix Kill-Mar. Civ. Engr. and Surv. (C. F. H. v. Blücher & Sons), Corpus Christi, Tex	Oct. 30, 1906
von Geldern, Edward. Engr. of Levee Dist. No. 2, Yuba City, Cal	May 5, 1908
Wachtel, Louis. Leveler, State Highway Comm., Gloversville, N. Y	Mar. 2, 1909
Waddell, Needham Everett. With McClintic-Marshall Constr. Co., Box 742, Kansas City, Mo	Sept. 1, 1908
Walker, Charles Leopold. Asst. Prof., Applied Mechanics, Cornell Univ., 218 University Ave., Ithaca, N. Y	April 6, 1909
Walker, Edward George. 337 Beverley Rd., Hull, England	April 2, 1907
Walker, George Johnson. Draftsman with Heyl & Patterson, Contr. Engrs. (Res., 5433 Elmer St.), Pittsburg, Pa	Dec. 6, 1904
Wall, Edward Walter. Civ. Eng. Dept., N. Y., N. H. & H. R. R., 409 Union Station, Providence, R. I	Dec. 6, 1910
Walton, Harry Collins. Designer, McClintic-Marshall Constr. Co., 21 Park Row, Room 1103, New York City	Jan. 5, 1909
Ward, Charles Henry, 2d. Middletown, R. I	Oct. 5, 1909
Ward, Edward Ashton. Draftsman, Bridge Dept., N. Y. C. & H. R. R. R., 335 Madison Ave., New York City	Oct. 5, 1909
Ward, George Merritt. Pres. and Gen. Mgr., George Merritt Ward, Inc., 350 West 58th St., New York City	Nov. 5, 1907
Warlow, Adoniram Judson. Bethlehem Steel Co., 313 W. North St., Bethlehem, Pa	May 1, 1906
Warner, Glenn. Asst. Engr., Cin., Hamilton & Dayton Ry., 63 Carew Bldg., Cincinnati, Ohio	Jan. 4, 1910
Warner, James Madison. Res. Engr., Pecos & Northern Texas Ry., Ovalo, Tex	April 6, 1909
Warrack, James Baldwin. Asst. Supt. of Constr., O. & W. R. R., 1310 Yesler Way, Seattle, Wash	Jan. 3, 1911

JUNIORS W-Z

		Date of Membership
	Watkins, Samuel Dale. 307 Roxborough Ave., Roxborough, Philadelphia, Pa.	Mar. 31, 1908
	Watson, George Linton. Chf. Engr., United Paving Co., 535 Bartlett Bldg., Atlantic City, N. J.	Mar. 6, 1906
	Weaver, Earll Chase. Asst. Engr., Hegardt & Clarke, Board of Trade Bldg., Portland, Ore.	Mar. 31, 1908
	Weber, Daniel Rishel. Care, Great Northern Ry. Co., Monroe, Wash.	Mar. 1, 1910
	Webster, Royal Sylvester. Asst. Engr., Havana Central R. R. Co., Egido 2, Havana, Cuba	Oct. 6, 1903
	Weller, William Earl. Deputy City Engr., 63 Robinson St., Schenectady, N. Y.	Jan. 7, 1908
	Wentworth, George Lansing. Care, New York City Board of Water Supply, Hill View Reservoir (Res., 11 West Radford St.), Yonkers, N. Y.	April 6, 1909
	Weston, Frederick Sampson. Care, Madeira-Mamoré Ry. Co., Porto Velho de Santo Antonio, Brazil	Oct. 5, 1909
	Wetherell, Dwight Nelson. 115 North Garrison Ave., Carthage, Mo.	Nov. 1, 1910
	Whitman, Kilborn, Jr. Asst. Engr., Board of Water Supply of New York City, 523 West 122d St., New York City	Sept. 6, 1910
	Whittemore, Leslie Clifford. Asst. Engr., Board of Water Supply, New York City, Cornwall-on-Hudson, N. Y.	May 3, 1910
	Wilbanks, John Robert. 518 Vermont Bldg., Salt Lake City, Utah.	June 4, 1907
	Wilder, Ellwood Coggeshall. 1718 Anapuni St., Honolulu, Hawaii.	June 30, 1910
C.	Wiley, Hugh Lemuel. 1040 East Main St., Portland, Ore.	April 2, 1907
	Wiley, Ralph Benjamin. Asst. Prof. of San. and Hydr. Eng., Purdue Univ., 123 Russell St., West Lafayette, Ind.	Feb. 4, 1908
	Willard, William Clyde. Prof. of Ry. and Highway Eng., Washington State Coll., Pullman, Wash.	Feb. 4, 1908
	Willcomb, George Edward. Chemist in Chg., Albany Filtration Works, 113 North Allen St., Albany, N. Y.	Oct. 30, 1906
	Willcox, James DeWitt. 1201 East 16th Ave., Denver, Colo.	Feb. 1, 1910
	Williams, Clement Clarence. Asst. Prof. of Civ. Eng., Univ. of Colorado, 1133 Pleasant St., Boulder, Colo.	June 1, 1909
	Williams, Rector Linde. Chf. Engr., Reinforced Concrete Co., 1608 Wright Bldg., St. Louis, Mo.	Sept. 1, 1908
	Willis, Albert Jones. Instr. in Civ. Eng., Cooper Union (Res., 499 East 176th St., Bronx), New York City	June 4, 1907
	Wilmot, James. 16 Elgin St., Providence, R. I.	Sept. 1, 1908
	Wilmot, Sydney. Junior Highway Engr., Office of Public Roads, Washington, D. C.	Nov. 8, 1909
	Wilson, Rodney Melledge. Field Engr., Consolidated Gas Co., 123 Woodland Ave., New Rochelle, N. Y.	May 31, 1910
	Wilson, Samuel. 4120 Kingman Boulevard, Des Moines, Iowa	April 3, 1906
	Wilson, William West. Berwyn, Pa.	Dec. 4, 1906
	Winans, Lawrence Lewis. Fruitville, Howell Co., Mo.	Nov. 8, 1909
	Winchester, Thomas Harrison. 66 Arlington Pl., Macon, Ga.	May 4, 1909
	Winsor, Harry Draper. Asst. Engr., Board of Water Supply, City of New York, 137 South Broadway, White Plains, N. Y.	Mar. 1, 1910
	Wintermute, Fred Clark. Civ. and Min. Engr. (Young & Wintermute), 410 Second National Bank, Wilkes-Barre, Pa.	July 1, 1909
	Wise, Russell Sherwood. 34 Bloomfield Ave., Passaic, N. J.	April 2, 1907
	Wittstein, Herman Lewis. Asst. Engr., Board of Water Supply, City of New York, High Falls, N. Y.	Oct. 6, 1908
	Wolkowyski, Alexander Ilich. Suwalki, Russia	Jan. 7, 1908
	Woodruff, Charles William. 420 Henry Bldg., Portland, Ore.	Jan. 4, 1910
	Wright, Albert Eugene. Springville, Utah	Mar. 3, 1908
	Wright, Rene Barber. Civ. and Structural Engr., U. P. R. R. Co., 2608 Ames Ave., Omaha, Nebr.	Aug. 31, 1909
	Wright, Thomas Judson, Jr. Asst. Res. Engr., Norfolk & West. Ry. Co., Bandy, Va.	June 1, 1909
	Wright, Thomas Temple. U. S. Junior Civ. Engr., Box 404, Vicksburg, Miss.	Sept. 1, 1908
	Wyckoff, Charles Rapelyea, Jr. Asst. Engr., Board of Water Supply, City of New York, Realty Bldg., White Plains (Res., 185 Penn St., Brooklyn), N. Y.	May 5, 1903
	Wygant, Robert Cecil. Asst. Engr., M. of W., Ore. R. R. & Nav. Co., 789 Corbett St., Portland, Ore.	Oct. 6, 1908
	Yarnell, David Leroy. Asst. Drainage Engr., U. S. Dept. of Agri., Drainage Investigations O. E. S., Washington, D. C.	April 5, 1910
	Yeo, William Albert. National Eng. Co., 500 Fifth Ave., Room 402, New York City	Oct. 1, 1907
	Zabriskie, Aaron J. 23 Fifth Ave., New York City	July 1, 1885

Juniors, 758.

FELLOWS.

[F. Am. Soc. C. E.]

	Date of Membership
Adams, Edward Dean. Pres. Bullock Elec. Mfg. Co.; Pres., Lehigh Coke Co.; Pres., East Jersey Water Co.; Chairman, Empire Eng. Corporation, 71 Broadway, New York City	Mar. 31, 1891
Albright, John Joseph. Buffalo, N. Y.	April 20, 1886
Belknap, William Richardson. 2d and Washington Sts., Louisville, Ky.	May 28, 1872
Blatchford, Eliphalet W. 1111 La Salle Ave., Chicago, Ill.	Feb. 6, 1873
Clark, Edward White. 321 Chestnut St., Philadelphia, Pa.	April 8, 1870
Coit, Edward Woolsey. Address unknown	Sept. 20, 1872
Darwin, Harry Gilbert. Mgr., Indian Cache Ranch; Vice-Pres. and Gen. Mgr., Waha-Lewiston Land & Water Co. (Res., 402 Prospect Ave.), Lewiston, Idaho	Mar. 22, 1887
du Pont, Biderman. 808 Broome St., Wilmington, Del.	Sept. 5, 1873
Everest, Charles Marvin. First Vice-Pres., Vacuum Oil Co., 506 West Ave., Rochester, N. Y.	Nov. 1, 1892
Farren, B. N. 1807 Spring Garden St., Philadelphia, Pa.	Mar. 12, 1870
Flint, Charles R. Flint & Co., 25 Broad St. (Res., 4 East 36th St.), New York City	June 7, 1876
Green, Samuel Magee. 1235 Wells Bldg, Milwaukee, Wis.	Sept. 5, 1888
Hill, James Jerome. Pres., G. N. Ry. Co., St. Paul, Minn.	Jan. 10, 1889
Holman, Stephen. 150 Atlantic Ave., Swampscott, Mass.	June 29, 1872
Kiddle, Alfred Watts. 115 Broadway, New York City	Oct. 3, 1893
Merritt, George. Address unknown	May 6, 1870
Meyer, Henry Coddington. 1 Madison Ave., New York City	Oct. 22, 1885
Richmond, Henry A. Cor., Delaware Ave. and Tupper St., Buffalo, N. Y.	July 7, 1870
Stanton, John Robert. 11 William St., New York City	April 4, 1899
Watson, James. Hopatcong House, Landing, N. J.	Dec. 5, 1872
Welton, Nelson James. Waterbury, Conn.	Jan. 20, 1873

Fellows, 21.

SUMMARY OF MEMBERSHIP, FEBRUARY 10th, 1911.

Honorary Members	9
Corresponding Members	2
Members	2 784
Associate Members	2 112
Associates	172
Juniors	758
Fellows	21
Total	5 858

GEOGRAPHICAL LIST

NORTH AMERICA.

CANADA. Total Membership, 111.

MEMBERS.—***Almonte, Ont.***—A. Bell. ***Amherstburg, Ont.***—C. Y. Dixon, H. Hodgman. ***Barrie, Ont.***—F. Moberly. ***Brandon, Man.***—R. E. Speakman. ***Calgary, Alta.***—G. A. McCarthy. ***Cochrane, Ont.***—A. T. Tomlinson. ***Dawson, Y. T.***—C. A. Thomas. ***Edmonton, Alta.***—J. Callaghan. ***Hamilton, Ont.***—J. Hobson, R. M. Roy. ***Hampton, N. B.***—E. G. Evans. ***London, Ont.***—A. H. Van Cleve. ***Medicine Hat, Alta.***—A. M. Grace. ***Moncton, N. B.***—P. S. Archibald. ***Montreal, Que.***—W. I. Bishop, F. S. Darling, G. H. Duggan, W. J. Francis, A. S. Going, F. P. Gutelius, H. Holgate, H. S. Holt, J. A. Jamieson, P. Johnson, H. G. Kelley, J. Kennedy, R. B. Kenrick, R. S. Lea, H. M. MacKay, W. McNab, J. Mayer, P. A. Peterson, A. W. Robinson, J. Ross, J. M. Shanly, F. P. Shearwood, V. K. Spicer. ***New Westminster, B. C.***—A. C. Eddy. ***Ottawa, Ont.***—S. J. Chapleau, C. R. F. Coutlee, S. Fleming, C. H. Keefer, T. C. Keefer, J. L. P. O'Hanly. ***Prince Rupert, B. C.***—J. H. Bacon. ***Sault Ste. Marie, Ont.***—L. H. Davis. ***Sherbrooke, Que.***—E. H. Drury. ***Sydney, N. S.***—M. J. Butler. ***Toronto, Ont.***—W. H. Breithaupt, W. Chipman, E. H. Keating, C. H. Mitchell, C. H. Rust, C. B. Smith, W. F. Tye ***Vancouver, B. C.***—R. F. Hayward, J. H. Kennedy, C. B. Vorce, W. C. Weeks. ***Vernon, B. C*** F. R. Johnson. ***Victoria, B. C.***—F. C. Gamble, E. Mohun. ***Walkerville, Ont.***—W. Pope. ***Winnipeg, Man.***—E. E. Brydone-Jack, W. A. James, H. N. Ruttan, J. G. Sullivan.

ASSOCIATE MEMBERS.—***Calgary, Alta.***—F. H. Peters. ***Dunnville, Ont.***—W. F. Scott. ***Fort William, Ont.***—H. S. Hancock, Jr. ***Hamilton, Ont.***—J. H. Shortt. ***Montreal, Que.***—C. B. Brown, Jr., L. N. Edwards, J. A. Grant, C. E. Gudewill, R. E. Hunter, C. M. Morssen, B. Ripley. ***Niagara Falls, Ont.***—K. F. Cooper. ***Ottawa, Ont.*** D. W. McLachlan. ***Penticton, B. C.***—M. E. Brooks. ***Prince Rupert, B. C.***—W. H. Ferguson. ***Red Deer, Alta.***—J. G. MacGregor. ***St. Boniface, Man.***—McC. P. Blair. ***Saint John, N. B.***—J. K. Scammell. ***St. Thomas, Ont.***—G. H. Harris. ***Saskatoon, Sask.***—E. B. L. Unger. ***Shawinigan Falls, Que.***—P. H. Falter. ***Toronto, Ont.***—A. C. D. Blanchard, F. F. Longley, C. W. Noble. ***Vancouver, B. C.***—J. R. Grant, C. P. Moss, J. V. Nimmo. ***Victoria, B. C.***—D. S. Hays. ***Winnipeg, Man.***—H. C. Baker, Jr., T. J. S. Edelen, H. Edwards, J. D. Matheson.

ASSOCIATES.—***Montreal, Que.***—A. Chaussé, T. J. Drummond.

JUNIORS.—***Halifax, N. S.***—C. D. Howe. ***London, Ont.***—K. M. Cameron. ***Montreal, Que.***—J. M. Barker, W. C. Brown, T. Leach. ***Toronto, Ont.***—E. W. Hyde, Jr. ***Vancouver, B. C.***—M. C. Burr. ***Victoria, B. C.***—H. S. Nichol. ***Walkerville, Ont.***—R. B. Leete.

MEXICO. Total Membership, 65.

MEMBERS.—***Aldama.***—J. W. Miles. ***Buenavista.***—L. Kingman. ***Cananea.***—L. D. Ricketts. ***Chihuahua.***—B. H. Bryant. ***Ciudad Juárez.***—M. M. Mendiola. ***Colima.***—A. P. Herbert, R. H. Vose. ***Culiacan.***—F. E. Butterfield. ***Guanajuato.***—W. H. Puffer. ***Guaymas.***—C. W. Raymond. ***Hermosillo.***—A. F. Wrotnowski. ***Mexico.***—R. Adam, F. Adams, M. M. Barragan, F. W. Blackford, J. B. Body, R. E. Briggs, S. Contri, S. J. Fortin, R Gayol, A. L. Jones, M. Marroquin y Rivera, A. L. Mills, A. Peimbert, G. Beltran y Puga, A. B. Ross, G. H. T. Shaw, E. K. Smoot, A. Y. Sundstrom, H. McG. Taylor. ***Monterey.***—J. E. Garrett, R. Meyer, N. Turner. ***Orizaba.***—S. W. Stacpoole. ***Rincon Antonio.***—A. M. C. Byers, R. T. Jordán. ***Salina Cruz.***—J. Shand. ***San Blas.***—E. A. H. Tays. ***Santa Fé.***—I. Mathewson. ***Sombrerete.***—H. L. Heldt. ***Tepehaunes.***—F. W. Andros. ***Tlahualilo.***—H. W. Potter. ***Vera Cruz.***—D. Coe, J. W. Richardson. ***Villaseñor.***—T. K. Mathewson.

ASSOCIATE MEMBERS.—***Cananea.***—C. E. Minor, V. R. Walling. ***Churubusco.***—W. A. Hill. ***Durango.***—C. J. Carroll, C. F. Parker. ***Estacion Penjamo.***—L. Whitbeck. ***Mexico.***—V. LeR. Havens, S. M. Navarrete, E. Ortiz, H. B. Pond. ***Monterey.***—W. O. Galbreath, V. Saucedo. ***Oaxaca.***—W. G. Fox. ***Pearson.***—W. Charnley, T. W. R. Teigen. ***Tierra Blanca.***—D. D. Colvin, C. P. Webber. ***Torreón.***—W. F. Lineberger. ***Vera Cruz.***—R. W. Whitaker.

ASSOCIATES.—***Durango.***—W. W. Graham.

UNITED STATES.

ALABAMA. Total Membership, 32.

MEMBERS.—***Birmingham.***—T. H. Aldrich, W. B. Allen, J. R. Carter, F. H. Crockard, J. W. Kendrick, S. Lea, Jr., F. H. Lewis, J. A. Montgomery, A. C. Olney, H. F. Wilson, Jr. ***Decatur.***—W. A. McCalla. ***Gantts Quarry.***—J. S. Sewell. ***Mobile.***—N. A. Yuille. ***Montgomery.***—D. M. Andrews. ***Tuscaloosa.***—C. M. Ayres.

ASSOCIATE MEMBERS.—***Auburn.***—G. N. Mitcham. ***Birmingham.***—D. O. Carr, F. Furlow, J. R. Pill. ***Mobile.***—L. T. Gaylord, J. M. Pratt. ***Pennington.***—W. Heer, Jr. ***Riverton.***—C. E. Bright ***Smith's Station.***—H. K. Hood. ***Tuscaloosa.***—G. K. Little, W. H. Nicol.

JUNIORS.—***Auburn.***—M. S. Harvey, ***Birmingham.***—L. M. Pill. ***Huntsville.***—N. B. Buchanan. ***Mobile.***—F. F. Pillet. ***Pennington.***—W. E. Hamilton. ***York.***—O. C. Lisman.

ALASKA. Total Membership 1

JUNIORS.—***Valdez.***—G. E. Edgerton.

ARIZONA. Total Membership, 18.

MEMBERS.—***Phœnix.***—L. C. Hill, F. Teichman. ***Prescott.***—W. A. Drake. ***Tucson.***—J. C. McClure. ***Yuma.***—J. D. Fauntleroy, F. L. Sellew.

ASSOCIATE MEMBERS.—***Phœnix.***—F. D. Angel, S. K. Baker, H. A. Cook, A. L. Harris, C. W. Smith, O. A. Turney. ***Tucson.***—G. E. P. Smith, L. A. Waterbury. ***Yuma.***—L. M. Lawson.

JUNIORS.—***Morenci.***—W. L. Du Moulin. ***Phœnix.***—F. L. Humphrey, W. M. Sanger.

ARKANSAS. Total Membership, 13.

MEMBERS.—***Fayetteville.***—E. A. Steece. ***Little Rock.***—P. R. Van Frank, Jr. ***Mansfield.***—G. E. Otis. ***Texarkana.***—H. DeW. Smith.

ASSOCIATE MEMBERS.—***Fayetteville.***—J. J. Knoch. ***Fort Smith.***—C. W. L. Armour. ***Little Rock.***—W. D. Dickinson, W. E. Ford, D. A. MacCrea, W. F. Reichardt, G. A. Watkins.

ASSOCIATES.—***Stamps.***—F. W. Green.

JUNIORS.—***Van Buren.***—S. Hardesty.

CALIFORNIA. Total Membership, 339.

HONORARY MEMBERS.—***Berkeley.***—G. E. Gray. ***San Francisco.***—G. Davidson.

MEMBERS.—***Alameda.***—O. W. Degen. ***Berkeley.***—C. Derleth, Jr., P. E. Harroun, J. M. Howells, C. G. Hyde, H. Kower. E. C. Murphy, F. Soulé. ***Bishop.***—W. H. Leffingwell. ***Calexico.***—H. T. Cory. ***Cowell.***—E. U. Leh. ***Dixon.***—J. Ahern. ***East Oakland.***—H. A. Schulze. ***Fresno.***—I. Teilman. ***Grass Valley.***—A. DeW. Foote. ***Hollywood.***—H. Alber. ***Inglewood.***—G. A. Wetherbee. ***Long Beach.***—T. Berry, J. J. Harding. ***Los Angeles.***—S. G. Bennett, G. S. Binckley, H. C. Boyden, W. A. Brackenridge, W. B. Clapp, W. H. Code, D. W. Cunningham, A. B. Fitch, J. A Fulton, J. P. Gardiner, H. E. Green, H. Hamlin, H. Hawgood, F. D. Howell, D. E. Hughes, W. D. Larrabee, J. B. Lippincott, W. Mulholland, E. Newman, F. H. Olmsted, O. K. Parker, J. L. Phillips, J. H. Quinton, W. H. Sanders. J. D. Schuyler, D. C. Serber, A. L. Sonderegger, S. Storrow, F. E. Trask, E. L. Veuve, E. D. Vincent, E. H. Warner, E. T. Wheeler, E. T. Wright, P. O. Wright, Jr. ***Mare Island.***—G. A. McKay. ***Maricopa.***—O. O. McReynolds. ***Mojave.***—A. C. Hansen. ***North Fork.***—G. S. Hewins. ***Oakland.***—E. M. Boggs, P. F. Brown, L. J. LeConte, F. T. Oakley. ***Orloff.***—C S. Compton ***Palo Alto.***—J. Herron, C. B. Wing. ***Pasadena.***—T. D. Allin, B. Moody. ***Pomona.***—A. W. Wright. ***Porterville.***—C. S. Freeland. ***Redlands.***—W. A. Nichols. ***Riverdale.***—H. E. Warrington. ***Riverside.***—W. E. Dauchy, J. R. Elliott. ***Sacramento.***—N. Ellery, P. M. Norboe, E. Oliver, G. N. Randle. ***San Diego.***—T. A. Bedford, A. B. Fletcher. ***San Francisco.***—A. L. Adams. F. J. Amweg, L. E. Ashbaugh, S. Baker, J. Q. Barlow, J. Biddle, A. M. Bienenfeld, B Bienenfeld, Le G. Brown, W. H. Brown, W. A. Cattell, H. De H. Connick, M. C. Couchot, G. L. Dillman. W. A. Doble, J. H. Dockweiler, R. G. Doerfling, E. Duryea, Jr., N. A. Eckart, W. R. Eckart, W. C. Edes, R. W. Fenn, G. R. Field, J. D. Galloway, H. D. Gates, W. B. Gester, C. E. Grunsky, E. F. Haas, W. H. Hall, W. C. Hammatt, G. J. Henry, Jr., F. C. Herrmann, W. H. Heuer, S. G. Hindes, L. J. Hohl, H. C. Holmes, H. Homberger, W. Hood, A. M. Hunt, T. H. Jackson, N. B. Kellogg, S. E. Kieffer, S. L. G. Knox, B. P. Legaré, J. B. Leonard, C. List, M. Manson, T. H. Means, W. Meredith, E. J. Molera, F. R. Muhs, M. M. O'Shaughnessy, V. H. Poss, F. J. H. Rickon, F. Riffle, E. A. Rix, E. J. Schneider, C. H. Snyder. M. L. Tower, C. Uhlig, R. W. Van Norden, O. von Geldern, H. H. Wadsworth, L. Wagoner, J. H. Wallace. J. H. G. Wolf, E. L. Woodruff. ***San José.***—J. G. McMillan. ***San Rafael.***—D. E. Melliss. ***Santa Barbara.***—J. R. Chapman, J. F. Flagg. ***Santa Clara.***—C. E. Moore. ***Santa Monica.***—F. Eaton. ***Saticoy.***—G. C. Power. ***Stanford University.***—J. C. L. Fish, C. D. Marx. ***Surrey.***—De W. L. Reaburn. ***Tiburon.***—F. Thompson. ***Willows.***—M. J. Lorraine, D. W. Ross. ***Yuba City.***—G. McMurtry.

ASSOCIATE MEMBERS.—***Alleghany.***—C. W. McMeekin. ***Bakersfield.***—A. T. Parsons, W. F. Whitaker. ***Berkeley.***—G. H. Baldwin, C. P. Bowie, W. V. Clark, E. L. Cope, B. A. Etcheverry, M. Nikolitch, A. V. Saph, T. B. Sears, E. L Soulé, G. B. Sturgeon, F. H. Tibbetts. ***Davenport.***—F. Davis. ***Exeter.***—J. H. Crosett. ***Fresno.***—W. R. Wheaton. ***Grass Valley.***—A. B. Foote. ***Imperial.***—R. S. Carberry. ***Larkin.***—T. G. Janney. ***Lompoc.***—R. R. McGregor. ***Los Angeles.***—J. C. Avakian, W. K. Barnard, W. F. Bixby, A. L. Bush, D. H. Campbell, J. C. Clausen. H. W. Dennis. C. A. Engle, J. B. Harris, C. W. Lawrence, C. R. Olberg, J. H. Payne, H. C. Phillips, W. S. Post, W. C. Sawyer, A. McC. Strong, W. M. Thomas, O. A. Wait, A. B. White, N. D. Whitman. S. W. Williams, W. Woodard. ***Monterey.***—T. B. Hunter. ***North Fork.***—H. M. Daugherty. ***Oakland.***—C. E. Beugler. W. S. Farley, W. N. Frickstad, W. C. Howe, P. Schuyler, G. Wilhelm. ***Ontario.***—C. L. McClelland. ***Orland.***—F. H. Tillinghast. ***Palo Alto.***—J. H. Foss. ***Pasadena.***—S. J. Van Ornum, F. E. Wilcox. ***Porterville.***—C. H. Holley. ***Portola.***—F. M. Robinson.

Richmond.—H. D. Chapman. ***Roseville.***—U. S. Marshall. ***Sacramento.***—W. E. Burns, G. B. Lorenz, C. Maughmer, J. F. Wilhelm. ***San Diego.***--B. B. Boyd, G. Butler, T. B. Downer, W. J. Gough, ***San Francisco.***—G. W. Armitage, D. Ash, M. J. Bartell, F. G. Baum, G. A. Bos, H. J. Brunnier, J. O. Burrage, P. L. Bush, H. A. Campbell, E. M. Chadbourne, R. S. Chew, G. J. Couchot, M. R. Daniels, W. P. Day, R. M. Drake, T. G. Elbury, C. E. Gilman, L. S. Griswold, H. L. Haehl, C. R. Hall, H. H. Hall, F. W. Haselwood, G. S. Hill, W. L. Huber, L. E. Hunt, L. R. Jorgensen, S. A. Jubb, A. Judell, A. Kempkey, Jr., N. B. Livermore, A. H. Markwart, O. C. Merrill, J. M. O'Hara, J. M. Owens, W. H. Popert, C. I. Rhodes, E. T. Thurston, Jr., G. W. Wade, F. G. White, J. H. Wise, C. N. Young. ***San José:***--A. Swickard. ***San Mateo.***—G. W. Corrigan, T. J. Jones. ***San Pedro.***--R. B. Kyle. ***San Rafael.***--E. N. Prouty. ***Santa Paula.***—A. C. Hardison. ***Santa Rosa.***—W. Egbert. ***South Berkeley.***—H. I. Dygert. ***South Pasadena.***—J. C. Hain. ***Stockton.***—W. B. Saunders. ***Vallejo.***—F. E. Frey. ***Visalia.***—H. H. Holley. ***Willows.***--W. G. Davies.

ASSOCIATES.—***Bakersfield.***—G. M. Herron. ***San Francisco.***—S. K. Colby. ***Visalia.***—J. C. Hays.

JUNIORS.—***Berkeley.***—A. J. Eddy, H. B. Foster, C. G. Gillespie, H. F. Gray, J. W. Gross, G. W. Howson, Jr., H. J. Kesner, T. K. Sweesy. ***East Auburn.***—E. L. Marsh, ***Groveland.***—O. J. Todd. ***Independence.***—C. H. Lee. ***Los Angeles.***—F. Gillelen, C. T. Leeds, F. W. McKinney, R. J. Reed. ***Los Banos.***—L. L. Carter. ***Mare Island.***—S. Gordon. ***Merced.***—A. R. W. Sperry. ***Modesto.***—A. Griffin. ***Monrovia.***—M. C. Halsey. ***Monterey.***—T. F. Rogers. ***Oakdale.***—W. E. Day. ***Oakland.***—A. W. Nordwell. ***Oroville.***—J. S. Hess. ***Palo Alto.***—R. A. Beebee, R. B. Moran, G. S. Strout. ***Sacramento.***—N. D. Baker, J. W, Horton, A. Teichert, Jr. ***San Diego.***—A. W. Earl. ***San Francisco.***—E. G. Brua, J. R. Cahill, L. L. Coleman, J. J. Ferrier, F. H. Fowler, E. H. Hatch, L. L. Hohl, T. D. Kilkenny, E. F. Kriegsman, G. G. McDaniel, LeR. McWethy, K. E. Parker, G. V. Rhodes, A. A. M. Russell, O. P. Shelley, A. L. Trowbridge, H. C. Vensano. ***San José.***—E. O. Billwiller, F. A. Nikirk, B. Read. ***Yuba City.***—E. von Geldern.

COLORADO. Total Membership, 82.

MEMBERS.—***Boulder.***—M. S. Ketchum. ***Canon City.***—A. R. Livingston. ***Denver.***—G. G. Anderson, H. W. Baum, J. A. Beeler, L. D. Blauvelt, G. M. Bull, H. J. Burt, C. W. Comstock, H. W. Cowan, H. S. Crocker, L. B. Curtis, J. W. Emig, J. E. Field, J. H. Frederickson, M. C. Hinderlider, G. N. Houston, J. B. Hunter, T. W. Jaycox, G. H. Matthes, H. F. Meryweather, W. Pearl, G. T. Prince, A. O. Ridgway, H. A. Sumner, R. S. Sumner, D. G. Thomas, J. C. Ulrich, C. D. Vail, E. F. Vincent, R. F. Walter, W. C. Wetherill, T. L. Wilkinson. ***Glenwood Springs.***—T. Rosenberg. ***Greeley.***—O. F. Shattuck. ***La Junta.***—F. M. Bisbee. ***Littleton.***—J. E. Maloney. ***Mack.***—M. W. Cooley. ***Paonia.***—W. B. Rittenhouse. ***Salida.***—J. W. Deen.

ASSOCIATE MEMBERS.—***Alamosa.***—C. B. Sampson. ***Canon City.***—R. F. Proctor. ***Denver.***—A. G. Allan, F. C. Carstarphen, F. E. Hermanns, W. P. Hufschmidt, E. C. Jansen, J. Y. Jewett, V. A. Kauffman, E. A. Lee, T. W. Norcross, A. Spengler, W. S. Winn, M. E. Witham, J. Y. Work. ***Fort Collins.***—L. R. Stockman. ***Golden.***—W. F. Allison. ***Grand Junction.***—S. O. Harper, J. H. Miner, E. L. Mosley. ***Greeley.***—P. A. Hartung, R. D. Tyler, J. R. Wortham. ***Holly.***—S. G. Porter. ***Montrose.***—J. H. Fertig. ***Penrose.***—W. Holbrook. ***Pueblo.***—A. A. Weiland. ***San Luis.***—W. DeW. Waltman. ***Trinidad.***—W. R. Lewis.

ASSOCIATES.—***Denver.***—L. C. Phipps.

JUNIORS.—***Boulder.***—C. C. Williams. ***Colorado Springs.***—H. A. Appel. ***Cripple Creek.***—A. L. B. Moser. ***Denver.***—T. Bartholomew, L. E. Bishop, L. R. Hinman, M. K. Jordan, G. R. Ogier, R. W. Toll, J. DeW. Willcox. ***Montrose.***—E. H. Swett. ***Telluride.***—T. Lindsley.

CONNECTICUT. Total Membership, 84.

MEMBERS.—***Berlin.***—D. E. Bradley, C. F. Chase. ***Bridgeport.***—T. B. Ford. ***Derby.***—D. S. Brinsmade. ***Hartford.***—G. M. Bond, H. R. Buck, R. N. Clark, F. L. Ford, R. F. Gadd, J. T. Henderson, T. H. Loomis, T. H. McKenzie, H. Souther. ***New Britain.***—C. M. Jarvis. ***New Haven.***—C. Blakeslee, A. J. Du Bois, W. R. Dunham, Jr., F. J. Easterbrook, C. C. Elwell, C. A. Ferry, H. H. Gladding, C. R. Harte, A. B. Hill, C. W. Kelly, E. W. Lewis, E. H. McHenry, E. E. Minor, W. H. Moore, C. H. Nichols, J. A. Norcross, H. L. Ripley, T. C. B. Snell, G. E. Verrill. ***New London.***—F. W. LaForge, H. Taylor. ***Noroton.***—A. H. Renshaw. ***Norwalk.***—R. Van Buren. ***Norwich.***—C. H. Preston. ***Saybrook.***—E. W. Bush. ***Stamford.***—H. A. Parsons. ***Waterbury.***—R. A. Cairns, C. H. Preston, Jr. ***West Haven.***—E. Gagel.

ASSOCIATE MEMBERS.—***Bridgeport.***—S. P. Senior. ***Derby.***—D. E. Brinsmade. ***Hartford.***—A. B. Alderson, W. J. Backes, A. H. Greenwood, R. C. Noerr, E. M. Peck, P. Sheldon, E. W. Wiggin. ***Meriden.***—C. L. Cole. ***Middletown.***—H. Miller. ***Milford.***—R. F. Stoddard. ***New Britain.***—A. W. Bacon, W. H. Hall. ***New Haven.***—E. W. Crawley, E. N. Sheffield, A. H. Terry. ***New London.***—H. L. Dunn. ***Norwich.***—L. M. Young. ***Old Lyme.***—H. T. Griswold. ***Thomaston.***--C. W. Eddy. ***Waterbury.***—W. T. Spencer. ***West Hartford.***—W. E. Johnson. ***West Haven.***—G. R. Johnson.

ASSOCIATES.—***Litchfield.***--D. G. Ambler. ***Stamford.***—G. A. Weber. ***Waterbury.***—M. A. O. Stilson.

JUNIORS.—***Berlin.***—G. B. Taylor. ***Bridgeport.***—H. L. Eames, H. A. Seeley. ***East Hartford.***—A. S. Brainard. ***Hartford.***—W. S. Brewer. ***New Haven.***—E. P. Leonard, A. S. Lynch, R. F. Roberts. ***New London.***—E. L. Chandler. ***Stamford.***--R. G. Rice, G. H. Stadel. ***Suffield.***--R. E. Spaulding. ***Thomaston.***—H. G. Payrow.

FELLOWS.—***Waterbury.***—N. J. Welton.

DELAWARE. Total Membership, 18.

MEMBERS.—***Delaware City.***—F. C. Warner. ***Edge Moor.***—E. Mowlds. ***New Castle.***—A. Bryson. ***Newark.***—J. R. Maxwell. ***Wilmington.***—W. H. Fenn, T. C. Hatton.

ASSOCIATE MEMBERS.—***Wilmington.***—H. W. Hatton, W. A. Heindle, E. R. Mack, H. L. Maier, A. J. Taylor.

ASSOCIATES.—***Wilmington.***—A. J. Moxham.

JUNIORS.—***Georgetown.***—I. P. Jones. ***Wilmington.***—W. J. Horrigan, J. A. Kienle, W. G. Rommel, P. F. Rossell.

FELLOWS.—***Wilmington.***—B. du Pont.

DISTRICT OF COLUMBIA. Total Membership, 106.

HONORARY MEMBERS.—***Washington.***—A. Mackenzie.

MEMBERS.—***Washington.***—W. H. Allen, F. L. Averill. T. C. J. Baily, Jr., E. C. Barnard, H. A. Belden, W. H. Bixby, F. C. Boggs, E. Burr, D. S. Carll, W. D. Connor, S. Cosby, L. M. Cox, W. Crozier. A. C. Cunningham, A. P. Davis, C. E. L. B. Davis, W. F. Dennis, E. M. Douglas, C. G. Elliott, M. T. Endicott, O. H. Ernst, O. B. French, F. Freyhold, B. R. Green, W. C. Gunnell, P. C. Hains, J. H. Hanna, E. D. Hardy, R. C. Hollyday, D. J. Howell, R. L. Hoxie, J. C. Hoyt, C. B. Hunt, W. V. Judson, M. W. Lewis, D. W. Lum, B. F. Mackall, W. A. McFarland, C. A. McKenney, R. B. Marshall, C. A. Miner, A. T. Mosman, D. W. Murphy, F. H. Newell, G. L. Nicolson, L. W. Page, W. N. Page. R. E. Peary, A. E. Phillips, F. C. Prindle, G. R. Putnam, P. L. Reed, F. Sutton, S. Tatum, O. H. Tittmann, A. H. Weber.

ASSOCIATE MEMBERS.—***Washington.***—R. E. Adams, C. Beale, E. C. Bebb, R. Coltman, Jr., J. S. Conway, F. H. Cooke, W. P. Darwin, G. R. Davis, H. Davis, L. S. Doten, J. R. Downman, W. A. E. Doying. C. F. Eberly, J. B. Gordon, U. S Grant, 3rd, E. C. Heald, J. P. Healy, N. H. Heck, E. A. Hill, L. M. Holt, H. B. Hurlbut, A. B. Ilsley, M. O. Leighton, W. C. Lyon, T. W. Marshall, F. E. Matthes, H. Munroe, R. Y. Patterson, T. J. Powell, H. A. Pressey, M. S. Rich, T. Riggs, Jr., C. L. Sadler, H. Stabler, H. Stidham, S. S. Storer, N. B. Sweitzer, C. H. Tompkins, W. McG. Wallace, F. R. Weller, R. Whitman.

ASSOCIATES.—***Washington.***—A. S. Cushman, E. C. Eckel, G. Pinchot.

JUNIORS.—***Washington.***—C. L. Hall, F. C. Hilder, G. R. Jones, S. Wilmot, D. L. Yarnell.

FLORIDA.—Total Membership, 29.

MEMBERS.—***Bartow.***—M. A. Waldo. ***Jacksonville.***—J. M. Braxton, F. W. Bruce, A. F. Harley, W. N. McDonald, F. C. Phillips, J. W. Sackett. ***Key West.***—F. O. Maxson. ***Pensacola.***—G. Rommel, Jr. ***St. Augustine.***—L. R. McLain. ***Tampa.***—W. H. Caldwell, B. Thompson.

ASSOCIATE MEMBERS.—***Green Cove Springs.***—J. E. Craig. ***Islamorada.***—P. L. Wilson. ***Key West.***—H. R. Hortenstine, G. R. Smiley. ***Marathon.***—R. W. Carter. ***Orlando.***—G. R. Ramsey. ***Palatka.***—R. F. Ensey. ***Pierce.***—A. Schneider. ***St. Augustine.***—J. T. Land, R. H. Martin. ***St. Petersburg.***—W. T. Turner. ***Tampa.***—W. W. Fineren.

JUNIORS.—***Gainesville.***—F. S. Parrigin. ***Jacksonville.***—H. I. Snyder. ***Key West.***—C. G. Bailey. ***Lakeland.***—H. D. Mendenhall. ***Port St. Joe.***—G. E. Dunan.

GEORGIA. Total Membership, 35.

MEMBERS.—***Albany.***—D. B. Dunn. ***Americus.***—G. M. Eldridge. ***Athens.***—J. W. Barnett, C. M. Strahan. ***Atlanta.***—A. Bonnyman, R. M. Clayton. P. A. Dallis. B. M. Hall, J. N. Hazlehurst. A. Pew. ***Augusta.***—N. Wingfield. ***Columbus.***—B. H. Hardaway, W. V. Polleys. ***Jackson.***—F. C. Shepherd. ***Savannah.***—G. M. Gadsden, H. S. Jaudon, J. de B. Kops, E. M. Rhett.

ASSOCIATE MEMBERS.—***Atlanta.***—T. P. Branch, A. V. Gude, Jr., W. A. Hansell, P. H. Norcross, C. E. Parsons, H. T. Poe, Jr., G. R. Solomon, W. C. Spiker, J. L. Zachry. ***Augusta.***—J. D. Twiggs, Jr. ***Brunswick.***—W. C. S. Lemen. ***Jackson.***—G. F. Harley. ***Rome.***—K. Lindsey.

JUNIORS.—***Augusta.***—G. M. Jones. ***Macon.***—T. H. Winchester. ***Savannah.***—E. C. Garvin, E. Neuhardt.

HAWAII. Total Membership, 15.

MEMBERS.—***Hilo.***—C. H. Kluegel, R. Quinn. ***Honolulu.***—A. C. Lewerenz, F. B. Smith, J. T. Taylor. ***Kahului.***—J. N. S. Williams.

ASSOCIATE MEMBERS.—***Honolulu.***—G. S. Burrell, W. F. Martin, E. Schmitt, E. A. Southworth, A. C. Wheeler.

JUNIORS.—***Honolulu.***—J. W. Caldwell, J. C. Foss, Jr., E. C. Wilder. ***Watertown.***—H. M. Goodman.

IDAHO. Total Membership, 42.

MEMBERS.—***Boise.***—C. H. Fitch, C. H. Paul, J. Stephenson, Jr., G. L. Swendsen, F. E. Weymouth, A. J. Wiley. ***Caldwell.***—J. T. Burke. ***Grangeville.***—W. H. Hill. ***Pocatello.***—W. R. Armstrong. ***St. Maries.***—M. S. Parker. ***Spirit Lake.***—W. C. Smith. ***Twin Falls.***—F. C. Horn.

ASSOCIATE MEMBERS.—***Boise.***—G. H. Bliss. F. M. Carhart, C. C. Fisher, A. B. Mayhew, J. F. Richardson, J. L. Savage, C. Spearman. W. G. Swendsen, W. Ward. ***Caldwell.***—H. S. Williams. ***Downey.***—S. D. Clinton. ***Pocatello.***—J. P. Congdon, J. N. McLoughlin, H. A. Roberts, G. N. Toops. ***Richfield.***—W. L. Gorton. M. R. Kays. I. W. McConnell. ***Rogerson.***—A. M. Gilbert, R. J. Newell. ***Rupert.***—P. M. Fogg, C. L. Huff. ***Twin Falls.***—C. B. Smith. ***Weiser.***—L. Highley.

JUNIORS.—***Arco.***—J. T. Henderson. ***Moscow.***—D. B. Steinman. ***Pocatello.***—W. C. Sweet. ***Salmon.***—N. M. Halcombe. ***Wendell.***—R. S. Larimer.

FELLOWS.—***Lewiston.***—H. G. Darwin.

ILLINOIS. Total Membership, 297.

MEMBERS.—***Alton.***—E. A. Hermann, T. C. Moorshead. ***Batavia.***—W. H. Finley. ***Champaign.***—I. O. Baker. ***Chicago.***—A. Allen, J. W. Alvord, W. E. Angier, W. C. Armstrong, B. J. Arnold, S. G. Artingstall, F. H. Avery, A. S. Baldwin, C. B. Ball, W. D. Barber, O. Bates, J. B. Berry, C. E. Billin, G. H. Binkley, W. L. Breckinridge, G. H. Bremner, D. J. Brumly, J. Brunner, H. M. Byllesby, W. J. Cahill, W. M. Camp, E. C. Carter, C. H. Cartlidge, G. B. Christie, T. W. Clayton, J. A. Cole, T. L. Condron, L. E. Cooley, W. L. Cowles, W. W. Curtis, C. R. Dart, F. E. Davidson, F. A. Delano, F. W. Dencer, C. M. Denise, De C. Dunlap, H. N. Elmer, J. E. Ericson, L. H. Evans, J. M. Ewen, W. B. Ewing, S. M. Felton, C. R. Fickes, H. B. Fleming, R. Forsyth, L. C. Fritch, J. R. Furman, J. L. Fyfe, R. E. Gaut, R. L. Gifford, H. P. Gillette, H. H. Hadsall, J. C. Hallsted, J. N. Hatch, C. D. Hill, J. B. Hittell, E. Holbrook, G. T. Horton, H. E. Horton, C. W. Hotchkiss, L. J. Hotchkiss, W. A. Hoyt, W. M. Hughes, R. W. Hunt, J. D. Isaacs, W. B. Jackson, C. L. Keller, J. W. Kendrick, E. H. Lawrence, E. N. Layfield, E. H. Lee, C. M. Leonard, F. J. Llewellyn, J. Lowe, C. F. Loweth, W. A. Lydon, D. MacAllister, E. McCullough, W. W. Marr, E. D. Martin, A. J. Mason, F. O. Melcher, L. J. Mensch, R. Modjeski, J. E. Moore, E. S. Nethercut, A. W. Newton, L. A. Nichols, W. R. Patterson, J. W. Pearl, E. T. Perkins, A. E. Phillips, A. V. Powell, I. Randolph, W. Raster, A. F. Reichmann, A. A. Righter, L. E. Ritter, A. F. Robinson, W. A. Rogers, W. H. Rosencrans, H. R. Safford, G. F. Samuel, C. Schroeder, E. K. Scott, E. C. Shankland, R. M. Shankland, E. L. Shaw, LeR. K. Sherman, F. F. Sinks, H. J. Slifer, D. Sloan, S. T. Smetters, G. W. Smith, R. C. Smith, I. F. Stern, W. B. Storey, Jr., O. E. Strehlow, C. L. Strobel, W. D. Taylor, J. C. Temple. M. K. Trumbull, F. G. Vent, H. U. Wallace, C. V. Weston, G. Weston, H. F. White, F. R. Williamson, P. Willis, E. B. Wilson, B. E. Winslow, G. M. Wisner, E. N. Wood, A. W. Woodman, A. Ziesing, G. A. Zinn, M. A. Zook. ***East St. Louis.***—T. N. Jacob, W. A. Thompson. ***Edwardsville.***—C. A. Sheppard. ***Evanston.***—W. H. Burger, J. F. Hayford, C. J. Morse. ***Joliet.***—F. C. H. Arentz. ***Litchfield.***—A. G. Kleinbeck. ***Moline.***—J. B. Bassett. ***Murphysboro.***—E. C. Finley. ***Peoria.***—D. H. Maury, S. M. Russell. ***Riverside*** —W. S. Smith. ***Rock Falls,***—H. E. Reeves. ***Rock Island.***—C. Keller, R. Monroe, A. L. Richards. ***Springfield.***—F. H. Hamilton, A. N. Johnson. ***Sterling.***—A. O. Rowse, L. L. Wheeler. ***Urbana.***—A. N. Talbot. ***Western Springs.***—J. Nichol.

ASSOCIATE MEMBERS.—***Bloomington.***—J. G. Melluish. ***Chicago.***—E. E. Adams, F. W. Adgate, W. H. Alderson, J. L. Allen, W. G. Arn, W. E. Belcher, J. C. Blaylock, W. J. Boucher, C. F. Brenn, I. C. Brower, R. M. Brown, C. B. Burdick, R. H. Burke, F. D. Chase, F. R. Coates, O. F. Cole, J. W. Cornell, A. A. Cother, J. W. Cowper, W. F. Day, S. Dean, W. W. DeBerard, S. T. De La Mater, J. T. Dickerson, H. S. Doyle, E. B. Espenshade, J. C. Fruit, E. J. Fucik, W. F. Graves, J. A. Green, P. E. Green, H. E. Grimm, G. E. Gustafson, T. L. D. Hadwen, E. McK. Hagar, W. S. Hanley, H. R. Harbeck, W. S. Hazelton, W. E. Ingram, M. Johnson, F. R. Judd, F. B. Knight, J. C. Koch, J. B. Koon, A. S. Lewis, J. W. Ludlow, J. L. McConnell, H. J. McDargh, W. I. Martin, F. E. Morrow, J. E. Murphy, J. Paige, L. Pearse, C. W. Petersen, L. E. Philbrook, T. C. Phillips, R. I. Randolph, E. H. Ravenscroft, H. B. Sauerman, W. A. D. Short, J. G. Spielman, J. W. Stewart, H. H. Stout, W. A. Theodorson, E. E. R. Tratman, W. P. Tunstall, S. Van Pelt, G. S. Walter, E. Walther, M. Wassner, J. V. Wescott, O. J. West, R. A. Widdecombe, A. Yappen. ***East St. Louis.***—R. L. Murphy. ***Effingham.***—C. C. Huestis. ***Evanston.***—H. B. Kirkpatrick, R. J. Middleton. ***Kewanee.***—J. E. Kemp. ***Monmouth.***—J. S. Bates. ***Mt. Carmel.***—A. M. Turner. ***North Chicago.***—C. D. Thurber. ***Peoria.***—J. A. Harman. ***Shelbyville.***—C. E. Chester. ***Springfield.***—H. E. Bilger, C. Older. ***Staunton.***—B. Cole. ***Thomson.***—C. Berry. ***Urbana.***—J. P. Brooks. F. O. Dufour, N. B. Garver, C. W. Malcolm.

ASSOCIATES.—***Chicago.***—R. E. Belknap, C. M. Foster, W. J. C. Kenyon, T. F. Quilty, L. P. Ryan, G. H. Scribner, Jr., S. M. Turrill, J. H. Warder.

JUNIORS.—***Batavia.***—LeB. Turner. ***Charleston.***—S. McCrory. ***Chicago.***—B. Borland, G. Bryan, Jr., J. E. Cahill, O. B. Carlisle, D. M. Dodds, W. R. Ewing, C. W. Gaylord, H. G. Gearhart, R. S. Gram, J. R. Hall, H. B. Hastings, H. W. Henes, S. T. Henry, T. H. Holmes, L. L. Hunter, C. B. Lewis, G. F. Maglott, D. H. Maxwell, G. H. Paine, H. G. Raschbacher, C. S. Reed, W. R. Robinson, G. Schobinger, J. R. Scott, Jr., R. G. Shankland, C. S. Stewart. ***East St. Louis.***—S. G. Smith. ***Urbana.***—D. A. Abrams, P. Soo-Hoo.

FELLOWS.—***Chicago.***—E. W. Blatchford.

INDIANA. Total Membership, 34.

MEMBERS.—***Indianapolis.*** W. G. Atwood, C. C. Brown, M. M. Defrees, R. P. Woods. ***Rushville.***—J. W. Moore. ***South Bend.***—F. A. Bryan, A. J. Hammond, R. B. Perrine. ***Terre Haute.***—M. A. Howe.

ASSOCIATE MEMBERS.- ***Anderson.***—L. A. Mitchell. ***Bedford.***—G. A. Haynes. ***Blountsville.*** -J. L. Dillard. ***Elkhart.*** A. M. Crain, S. H. Scharschmidt. ***Evansville.***—P. Chipman. ***Hammond.***- M. E. Shire. ***Indianapolis.***- T. R. H. Daniels, A. C. Harrington, A. R. Holliday, W. H. Insley, E. C. Strathmann. ***Lafayette.***—H. O. Garman, W. K. Hatt, R. L. Sackett. ***La Porte.***- E. C. Shoecraft. ***Logansport.***—H. W. Brown, H. F. Coleman. ***Valparaiso.***—R. S. King. ***West Lafayette.***—G. W. Case.

ASSOCIATES. -***Indianapolis.***—H. E. Jordan. ***West Lafayette.***—A. P. Poorman, A. Smith.

JUNIORS.—***Indianapolis.***—J. E. Hall. ***West Lafayette.***—R. B. Wiley.

IOWA. Total Membership, 31.

MEMBERS.—***Ames.***—A. Marston. ***Burlington.***—F. D. H. Lawlor. ***Davenport.***—G. H. Boynton, C. Francis, W. H. Kimball. ***Des Moines.***—R. T. Hartman, J. B. Marsh. ***Iowa City.***—W. G. Raymond. ***Keokuk.***—M. Meigs, B. H. Parsons.

ASSOCIATE MEMBERS.—***Ames.***—H. C. Ford, H. W. Gray, J. E. Kirkham. ***Clinton.***—R. C. Hart. ***Davenport.*** N. A. Melick. ***Des Moines.***—P. Beer, C. H. Fuller, L. Goodman, I. D. Goodwin, M. H. Kanary, J. E. Van Liew. ***Iowa City.***—B. J. Lambert. ***Sioux City.***—P. D. Cook.

JUNIORS.—***Ames.***—V. D. Beard. ***Des Moines.***—M. DeM. Gates, C. Millard, S. Wilson. ***Dows.***—G. H. Mack. ***Iowa City.***—R. E. Hutchins. ***Sioux City.***—K. C. Gaynor. ***West Side.***—C. A. Bock.

KANSAS. Total Membership, 34.

MEMBERS. -***Atchison.***—F. Giddings. ***Fort Leavenworth.***—M. L. Walker. ***Lawrence.***—B. J. Dalton, W. McGrath, F. O. Marvin. ***Leavenworth.***—E. H. Connor, W. H. Jones, G. W. Vaughn. ***Topeka.***—C. F. W. Felt, E. W. Grant, C. A. Morse, A. A. Robinson, H. M. Stone.

ASSOCIATE MEMBERS. -***Iola.***—L. A. Hunt. ***Kansas City.***—A. M. Munn. ***Lawrence.***—W. C. Hoad, J. De N. Macomb, Jr., H. A. Rice. ***Leavenworth.***—E. H. Barkmann, J. O'Neil. ***Manhattan.***—C. M. Buck, L. E. Conrad, W. S. Gearhart. ***Newton.***—O. Moorshead. ***Pittsburg.***—L. E. Curfman. ***Salina.***—C. A. Slayton. ***Topeka.***—L. B. Smith, J. Weidel.

ASSOCIATES.—***Iola.***—H. Struckmann.

JUNIORS.—***Fort Leavenworth.***—O. L. Eltinge. ***Lawrence.*** E. H. Dunmire, N. T. Veatch, Jr. ***Topeka.***—R. D. M. Henley. ***Wichita.***—S. T. Harding.

KENTUCKY. Total Membership, 50.

MEMBERS.—***Columbus.***—A. T. Sabin. ***Earlington.***—J. B. Atkinson. ***Frankfort.***—L. S. Johnson. ***Lexington.***—W. D. Pickett. ***Louisville.*** -W. C. Brohm. W. H. Courtenay, S. F. Crecelius, J. L. Frazier, W. Gazlay, W. E. Hutchings, J. M. Johnson, E. E. Kuersteiner, T. A. Leisen, R. Montfort, M. Morris, J. H. Peyton, S. S. Roberts. G. W. Shaw, W. M. Venable, J. E. Willoughby, C. B. Wilson, E. Zarbell. ***Middlesboro.***—W. E. Gunn. ***Newport.***—W. L. Glazier. ***St. Matthews.***—R. Fink.

ASSOCIATE MEMBERS.—***Bowling Green.***—P. Hansen. ***Covington.***—F. H. Haskell. ***Eadsville.***—J. S. Butler. ***Frankfort.*** -H. G. McCormick. ***Louisville.***—F. A. Busse, M. Elliott, W. D. Gray, L. W. Hancock, F. I. Louckes, W. N. Morrill, H. S. Morse, J. H. L. Vogt, J. B. Wilson. ***Newport.***—E. Gray, Jr., A. H. Horton. ***Paducah.***—S. A. Miller.

ASSOCIATES.—***Louisville.***—J. B. Speed.

JUNIORS.—***Louisville.***—H. H. Cartwright, R. DeL. French, F. E. Hayes, Jr., J. B. Hutchings, Jr., A. A. Krieger, W. S. Moore, F. C. Tolles.

FELLOWS.—***Louisville.***—W. R. Belknap.

LOUISIANA. Total Membership, 42.

MEMBERS. ***Alexandria.***—C. C. Crew, I. W. Sylvester. ***Baton Rouge.***—M. P. Robertson. ***New Orleans.*** T. H. Barnes, L. H. Beach, A. C. Bell, A. L. Black, H. Burgess, J. F. Coleman, R. L. Crump, G. McC. Derby, C. Donovan, G. G. Earl, J. T. Eastwood, W. B. Gregory, W. J. Hardee, B. M. Harrod, J. C. Haugh, F. M. Kerr, W. E. Knobloch, S. F. Lewis, A. Perrilliat, A. L. Phillips, A. Raymond, C. W. Wood, W. B. Wright, S. McC. Young. ***Shreveport.***—W. R. Smith.

ASSOCIATE MEMBERS. ***Bogalusa.***—C. R. Howard. ***Boyce.***—G. W. Hillman. ***Burrwood.***—J. B. Lindhé. ***Monroe.*** A. K. Downes. ***New Iberia.***—R. J. Lockwood. ***New Orleans.***—W. C. Barton, A. M. N. Blamphin, J. R. Hardesty, E. L. Jahncke, C. W. J. Neville, A. M. Shaw.

JUNIORS.—***Burrwood.***—F. D. Cefalu. ***Monroe.***—J. E. Teal. ***New Orleans.***—O. Lake.

GEOGRAPHICAL DISTRIBUTION

MAINE. . Total Membership, 26.

MEMBERS.—***Augusta.***—C. C. Babb, H. F. Hill. ***Bangor.***--P. H. Coombs, G. H. Hamlin. ***Gardiner.***—F. Danforth. ***Houlton.***—M. Burpee. ***Lewiston.***—W. H. Sawyer. ***Madison.***—C. S. Humphreys. ***Millinocket.***—H. S. Ferguson. ***Portland.***—E. C. Jordan. ***Rockland.***—O. H. Tripp. ***Rumford.***—C. A. Mixer.

ASSOCIATE MEMBERS.—***Bangor.***—G. A. Hersey. ***Bonny Eagle***—G. G. Shedd. ***Houlton.***—L. B. Lincoln, P. C. Newbegin. ***Millinocket.***—F. C. Bowler, H. P. Hoyt. ***Orono.***—H. S. Boardman. ***Portland.***—W. A. Clapp, W. H. Norris, H. H. Robinson. ***Searsport.***—J. H. Duncan. ***Sullivan Harbor.***—P. D. Simpson.

JUNIORS.—***Portland.***—E. L. Lynch. ***Woodfords.***—A. B. Green.

MARYLAND. Total Membership, 70.

MEMBERS.—***Baltimore.*** —P. A. Beatty, A. M. Brosius, H. D. Bush, M. Cohen, W. W. Crosby, J. S. Doyle, W. R. Edwards, B. T. Fendall, J. Fisher, H. Fox, J. E. Greiner, F. H. Hambleton, C. W. Hendrick, J. M. Hood, Jr., W. D. Janney, W. L. Kenly, F. A. Kummer, O. F. Lackey, H. A. Lane, M. A. Long, T. D. Pitts, A. M. Quick, J. N. Shannahan, L. F. Smith, W. F. Strouse, F. L. Stuart, H. R. Talcott, A. W. Thompson, W. D. Uhler, T. M. Ward, F. S. Washburn, F. C. Wolfe. ***Catonsville.***—G. B. Hazlehurst. ***Colgate.***—E. B. Whitman. ***Darlington.***—J. H. Harlow. ***Hagerstown.***—J. B. Ferguson. ***Oella.***—G. R. Heckle.

ASSOCIATE MEMBERS.—***Annapolis.***—A. L. Parsons. ***Baltimore.***—R. N. Begien, G. D. Brooke, R. L. Burwell. R. L. Chamberlaine, E. D. Cummings, L. Dorsey, W. H. Dorsey, I. O. Harper, A. H. Hartman, A. H. Krone, E. C. Lawrence, C. P. McCausland, G. C. Saunders, G. W. C. Whiting, J. L. Wickes. ***Cumberland.***—H. Rittenhouse. ***Darlington.***—J. H. Harlow, Jr. ***Denton.***--H. A. Paine. ***Frostburg.***—E. S. Johnson.

ASSOCIATES.--***Baltimore.***—W. A. Polk. ***Frostburg.***—J. F. Wrenn.

JUNIORS.—***Annapolis.***—E. T. Hayman. ***Baltimore.***—I. Behrman, L. Bernstein, F.W. Caspari, L. Chevalier, J. N. Mackall. W. W. Pagon. H. S. Regester. Jr., R. L. Reimann-Hansen. ***Chestertown.***—M. deK. Smith, Jr. ***Salisbury.***—L. E. Perry.

MASSACHUSETTS. Total Membership, 293.

HONORARY MEMBERS.--***Lowell.***--H. F. Mills.

MEMBERS.—***Amherst.***—J. E. Ostrander. ***Auburndale.***—W. P. Snow. ***Boston.***—F. V. Abbot, H.S. Adams, C. E. Alderman, C. F. Allen, N. F. Ambursen, H. B. Andrews, T. Appleton, W. H. Arnold, T. Aspinwall, W. M. Bailey, F. A. Barbour, H. K. Barrows, W. I. Baucus, D. Brackett, E. W. Branch, G. H. Brazer, F. Brooks, M. F. Brown, W. M. Brown, A. E. Burton, M. M. Cannon, H. H. Carter, A. S. Cheever, S. Child, W. L. Church, E. C. Clarke, F. S. Curtis, H. C. Daggett, R. B. Davis, A. W. Dean, E. S. Dorr, H. P. Eddy, C. Eldridge, S. C. Ellis, G. C. Emerson, F. H. Fay, B. R. Felton, J. N. Ferguson, W. E. Foss, F. L. Fuller, X. H. Goodnough, B. W. Guppy, W. H. Ham, G. E. Harkness, E. Harrington, H. C. Hartwell, T. T. H. Harwood, H. W. Hayes, H. A. Herrick, F. W. Hodgdon, E. W. Howe, D. C. Jackson, W. S. Johnson, F. C. Kimball, G. A. Kimball, H. S. Kimball, E. N. Lake, J. A. Leonard, W. W. Lewis, H. V. Macksey, C. T. Main, L. B. Manley, L. Metcalf, E. F. Miller, H. A. Miller, W. N. Patten, E. E. Pettee, F. C. Pillsbury, A. L. Plimpton, D. Porter, J. R. Rablin, I. Rich, J. W. Rollins, Jr., W. Rotch, L K. Rourke, R. A. Shailer, F. E. Shedd, C. W. Sherman, F. A. Snow, J. P. Snow, C. M. Spofford, F. P. Stearns, J. H. Sullivan, L. A. Taylor, S. E. Tinkham, E. A. Tucker, E. K. Turner, L. C. Wason, W. Watson, De W. C. Webb, B. T. Wheeler, W. Wheeler, F. O. Whitney, H. B. Wood, C. J. H. Woodbury, J. R. Worcester. ***Brookline.***—H. B. Burley, W. H. Chadbourn, Jr., D. FitzGerald, A. H. French, H. Ropes, E. E. Stone, C. R. Suter. ***Cambridge.***—W. L. Butcher, H. J. Hughes, L. J. Johnson, E. D. Leavitt, W. Martin, J. C. Moses, J. C. Scorgie, G. F. Swain. ***Chelsea.***—W. E. McClintock. ***Clinton.***—H Parker. ***Dorchester.***—F. A. McInnes, A. H. Morrill, G. S. Morrill, J. E. Palmer, L. L. Street. ***Fall River.***—R. H. Beattie, B. T. Buffinton, A. Wolstenholme. ***Foxboro.***—F. J. Wood. ***Gloucester.***—H. W. Spooner. ***Haverhill.*** -R. R. Evans. ***Holyoke.***—E. P. Butts, E. A. Ellsworth, J. L. Tighe. ***Hyde Park.***—E. A. W. Hammatt. ***Jamaica Plain.*** -S. C. Heald. ***Lawrence.***—R. A. Hale, I. L. Sjöström. ***Lee.***—W. W. Maclay. ***Lowell.***—G. Bowers, C. L. Hammond, A. T. Safford. ***Lynn.***—C. W. Gay. ***Malden.*** H. A. Carson, R. L. Read. ***Melrose.***—C. T. Fernald. ***New Bedford.***—A. B. Drake, W. F. Williams. ***Newton Center.*** D. H. Andrews. ***Newton Highlands.***--S. E. Thompson. ***North Adams.*** F. B. Locke. ***North Attleborough.***—F. T. Westcott. ***Pittsfield.***—J. L. Howard. ***Plymouth.***—W. H. Sears. ***Ponkapoag.***—H. Bissell. ***Quincy.***—E. H. Howard. ***Roxbury.***—H. N. Cheney. ***Sandwich.***—C. L. Crandall, H. W. Durham, F. D. Fisher. ***Sharon.***—E. S. Safford. ***Somerville.***—W. F. Goodrich. ***South Yarmouth.***—C. H. Davis. ***Springfield.***—S. M. Green, G. N. Merrill, C. M. Slocum, D. M. Wheeler. ***Taunton.***—L. Dean. ***Tufts College.***—F. B. Sanborn. ***Turners Falls.***—C. W. Hazelton. ***Wakefield.***—G. M. Tompson. ***Walpole.***—W. L. Bowker. ***Waltham.***—B. Brewer, C. R. Perry. ***Wellesley.*** T. W. Baldwin. ***Westborough.***—W. J. Mozart. ***Westfield.***—O. E. Parks. ***West Newton.*** W. P. Morse, E. H. Rogers, H. D. Woods. ***West Roxbury.***—H. Manley. ***Woburn.***—W. W. Cummings. ***Worcester.***—C. A. Allen, R. H. Brown, W. E. Buck, A. W. French, L. B. Jenckes, E. F. Miner, S. H. Pitcher.

ASSOCIATE MEMBERS.—***Amherst.*** -J. S. Goodell. ***Andover.*** -C. Goldsmith. ***Beverly.***—C. H. Farnham. ***Boston.***—C. S. Allen, E. F. Atwood, W. T. Barnes, J. V. Beekman, Jr., E. P. Bliss, C. B. Breed, B. S. Brown, G. P. Carver, P. M. Churchill, L. S. Cowles, F. W. Daggett, G. D. Emerson, A. D. Fuller, R. D. Gardner, R. K. Hale, H. K. Higgins, C. J. Hogue, J. H. Richardson,

E. F. Rockwood, N. H. Sanderson, J. C. Schaeffler, A. L. Scott, W. H. Sears, E. R. Simpson, W. F. Steffens, F. L. Tibbetts, R. S. Weston, N. R. Willard. ***Brookline.***—W. T. Shaw. ***Buzzards Bay.***—C. T. Waring. ***Cambridge.***—F. H. Carter, C. W. Killam, H. F. Sawtelle, J. Ware. ***Charlestown.*** E. C. Hayden. ***Clinton.***—E. R. B. Allardice. ***East Walpole.***—E. Hutchins. ***Fall River.***—W. E. Noble. ***Fitchburg.*** F. C. Davis. ***Gleasondale.***—W. C. Lambert. ***Hingham.***—R. L. Whipple. ***Holyoke.*** A. F. Sickman. ***Ludlow.***—C. E. Quinby. ***Malden.***—W. E. Barnes. ***Manchester.***—R. C. Allen. ***New Bedford.*** I. M. Chace, Jr., R. D. Chase, W. H. Chase. ***Newtonville.***—L. E. Moore. ***North Cambridge.***—H. F. Howe. ***Pittsfield.***—A. B. Farnham, C. B. Lindholm, F. A. Spaulding, M. M. Thrane. ***Quincy.***—J. K. Freitag, P. Lawton. ***Sandwich.***—A. S. Ackerman. ***South Framingham.***—W. W. Locke. ***South Hadley Falls.***—M. J. Leahy. ***Springfield.*** E. E. Lochridge. ***Tufts College.***—E. H. Rockwell. ***Tyngsborough.***—J. R. Taft. ***Waltham.***—G. W. Cutting, Jr., C. H. Dutton, H. B. Pratt. ***Westfield.***—J. L. Hyde. ***West Roxbury.***—C. R. Gow. ***Winthrop.***—R. M. Conner, G. M. Stevens. ***Worcester.***—C. M. Allen, V. P. Curtis, H. C. Ives, H. P. Wilson.

ASSOCIATES.—***Boston.***—C. H. Eglee, H. W. Hayward, H. A. Phillips. ***Pittsfield.***—E. T. Belden. ***West Chelmsford.***—J. J. Monahan.

JUNIORS.—***Boston.***—E. W. Bowditch, J. E. Cunningham, W. E. Lydston, C. R. Marsh, F. A. Marston, R. W. Parlin. ***Cambridge.***—W. B. Bushway, J. R. Nichols. ***East Walpole.***—A. C. Johnston. ***Hyde Park.***—W. W. Clifford. ***Jamaica Plain.***—G. Johnson. ***Malden.***—C. R. Turner. ***Medford.***—E. A. Norwood. ***New Bedford.***—E. J. Potter. ***Newton Highlands.***—W. O. Lichtner ***North Adams.*** W. C. Emigh. ***Roxbury.***—H. Nawn. ***Sandwich.***—F. S. O'Reilly. ***Sherborn.***—T. L. Paul. ***Springfield.***—A. C. King, W. B. Thomson. ***Waltham.***—W. W. Bigelow, G. Small. ***West Medway.***—J. R. Lapham. ***Wollaston.***—H. C. Poore. ***Worcester.***—G. W. Burpee.

FELLOWS.—***Swampscott.***—S. Holman.

MICHIGAN. Total Membership, 91.

MEMBERS.—***Ann Arbor.***—J. B. Davis, C. T. Johnston, C. L. de Muralt, E. D. Rich, G. S. Williams. ***Detroit.***—A. B. Atwater, F. T. Barcroft, B. Douglas, A. Dow, H. H. Esselstyn, G. H. Fenkell, J. D. Hawks, H. S. Hodge, F. B. Howard, J. C. Hutchins, G. H. Kimball, M. S. MacDiarmid, R. H. McCormick, T. F. McCrickett, F. G. Ray, C. McD. Townsend, J. A. Ubsdell, Jr., H. A. E. C. von Schon, G. H. Webb, A. J. Wenzell, E. S. Wheeler, S. D. Williams, Jr. ***Grand Rapids.***—E. H. Barnes, L. W. Goddard, D. McCool, K. S. Riser. ***Harbor Beach.***—E. J. Duffies. ***Jackson.***—W. G. Fargo, R. M. Newman. ***Kalamazoo.***—G. S. Pierson. ***Lapeer.***—F. Morley. ***Manistee.***—E. W. Muenscher. ***Marquette.***—R. C. Young. ***Saginaw.***—F. T. Hepburn. ***Sault Ste. Marie.***—I. De Young, W. J. Graves, L. C. Sabin.

ASSOCIATE MEMBERS.—***Ann Arbor.***—C. A. Ellis, A. E. Greene, J. H. Griffith, H. B. Merrick, C. J. Tilden. ***Detroit.***—W. Burton, G. R. Cooke, N. C. Fenkell, G. S. Gildersleeve, M. Goldenberg, J. T. N. Hoyt, J. Kahn, P. M. Louwerse, R. F. Moss, J. H. Poole, E. C. Soper, R. R. Tinkham, E. M. Walker. ***Grand Rapids.***—G. M. Ames, W. S. Bake, J. R. Fitzpatrick. ***Houghton.***—G. H. Banks. ***Jackson.***—J. C. Lathrop. ***Negaunee.***—W. F. Collar. ***Port Huron.***—R. Le H. Mahon. ***Rochester.***—L. H. Egan. ***St. Joseph.***—C. E. Chappell. ***Ypsilanti.***—J. E. Evans.

ASSOCIATES.—***Ann Arbor.***—H. H. Atwell. ***Grand Rapids.***—F. L. Gaines. ***Saginaw.***—G. L. Burrows.

JUNIORS.—***Allegan.***—C. F. Peck. ***Ann Arbor.***—L. E. Ayres, A. J. Decker, H. K. Holland, G. H. Knutson, C. W. Spooner. ***Detroit.***—R. A. Reynolds. ***Flint.***—C. I. Auten. ***Grand Rapids.***—R. E. Harrison. ***Ishpeming.***—C. B. Hawley. ***Ithaca.***—T. H. H. Harrod. ***Jackson.***—C. A. Biggs. ***Kalamazoo.***—W. W. Tefft. ***Petersburg.***—A. S. Russell. ***Sault Ste. Marie.***—W. M. Rich, R. R. Ryan, S. D. Strong. ***Wells.***—G. T. Stephenson.

MINNESOTA. Total Membership, 65.

MEMBERS.—***Albany.***—S. Wimmer. ***Duluth.***—H. C. Ash, C. Coleman, J. H. Darling, G. D. Fitch, F. E. House, T. F. McGilvray, D. A. Reed, G. A. Taylor. ***Hopkins.***—F. W. Cappelen. ***Minneapolis.***—W. Buehler, F. H. Constant, W. P. Cowles, W. de la Barre, L. S. Gillette, J. B. Gilman, W. S. Hewett, E. H. Loe, W. D. Lovell, C. H. Prior, F. C. Shenehon, H. E. Stevens, G. W. Sublette, C. A. P. Turner, G. H. White, G. L. Wilson. ***St. Paul.***—C. Le R. Annan, R. B. C. Bement, O. Claussen, W. L. Darling, J. R. W. Davis, A. H. Hogeland, G. H. Hutchinson, C. J. A. Morris, L. W. Rundlett, D. C. Shepard, H. E. Stevens, L. P. Wolff.

ASSOCIATE MEMBERS.—***Duluth.***—F. A. Cokefair, S. G. Collins, W. G. Zimmermann, ***Eyota.***—C. F. Brush. ***Minneapolis.***—F. H. Bass, E. H. Bruntlett, A. S. Cutler, F. M. Henry, S. G. Jones, B. W. Ranson, R. D. Thomas. ***St. Paul.***—C. R. Adams, K. Alexander, J. G. L. Cunningham, D. A. Daly, R. Follansbee, R. Hamlin, J. C. Sesser, P. E. Stevens, J. T. Stewart, M. J. Thompson, M. Toltz.

ASSOCIATES.—***St. Paul.***—H. Elliott.

JUNIORS.—***Minneapolis.***—D. I. Okes.

FELLOWS.—***St. Paul.***—J. J. Hill.

MISSISSIPPI. Total Membership, 27.

MEMBERS.—***Clarksdale.***—A. L. Dabney, T. G. Dabney. ***Gautier.***—J. B. Lindsey, Jr. ***Greenville.***—A. Hider, R. Somerville, C. H. West. ***Jackson.***—W. G. Kirkpatrick, M. L. Lynch. ***Natchez.***—E. B. Geddes. ***Vicksburg.***—H. M. Marshall, A. M. Todd, E. C. Tollinger.

ASSOCIATE MEMBERS.—***Hattiesburg.***—J. W. Davenport. ***Jackson.***—F. P. Hamilton. ***Vicksburg.***—E. S. Maupin, A. A. Woods. ***Water Valley.***—O. T. Dunn.

JUNIORS.—***Agricultural College.***—R. W. Gay. ***Greenville.***—F. Eberspacher, W. E. Elam. ***Jackson.***—C. H. Shapleigh. ***Vicksburg.***—P. E. Cunningham, A. W. Dann, G. P. F. Jouine, R. C. Lilly, R. L. Tatum, T. T. Wright.

MISSOURI. Total Membership, 190.

MEMBERS.—***Columbia.***—C. Hill, A. L. Hyde, F. P. Spalding. ***Independence.***—E. M. Stayton. ***Joplin.***—J. C. Barr. ***Kansas City.***—L. R. Ash, E. J. Beard, A. M. Blodgett, D. Bontecou, C. S. Burns, V. H. Cochrane, W. W. Colpitts, J. L. Darnell, G. E. Ellis, H. A. Fitch, S. W. Fox, J. V. Hanna, E. A. Harper, J. L. Harrington, I. G. Hedrick, F. W. Honens, J. W. Hoover, W. Kiersted, W. S. Kinnear, J. A. Lahmer, R. J. McCarty, R. E. McDonnell, A. Maitland, Jr., M. P. Paret, H. K. Seltzer, J. H. Smith, H. F. Taylor, L. Treadwell, A. A. Trocon, J. A. L. Waddell, R. W. Waddell. ***Marceline.***—G. J. Bell. ***Mexico.***—C. F. Stephens. ***Rolla.***—E. G. Harris. ***St. Louis.***—W. G. Brenneke, B. L. Brown, M. L. Byers, O. W. Childs, B. H. Colby, A. O. Cunningham, E. B. Fay, S. B. Fisher, W. L. Fisk, E. Flad, J. T. Garrett, R. P. Garrett, C. Gayler, E. L. Harman, F. T. Hatch, J. F. Hinckley, M. L. Holman, J. R. Hudson, A. L. Johnson, F. G. Jonah, C. H. Ledlie, B. McKeen, J. A. McKim, R. E. McMath, C. V. Mersereau, C. H. Miller, W. S. Mitchell, R. Moore, F. Neher, J. A. Ockerson, F. Y. Parker, H. Phillips, R. H. Phillips, J. Pitzman, C. L. Potter, C. de la C. Purdon, H. L. Reber, H. Rohwer, S. B. Russell, H. P. Taussig, J. L. Van Ornum, R. L. Van Sant, E. E. Wall, J. W. Woermann.

ASSOCIATE MEMBERS.—***Benton.***—J. E. Warner. ***Columbia.***—E. B. Cauthorn, D. B. Duncan, W. S. Williams. ***Excelsior Springs.***—S. W. Henderson. ***Joplin.***—J. B. Hodgdon. ***Kansas City.***—R. C. Barnett, E. B. Black, F. G. Cudworth, A. R. Eitzen, A. C. Everham, W. S. Haldeman, J. C. Herring, E. E. Howard, F. D. Hughes, C. E. Johnston, R. E. Koon, J. C. Long, B. Lowther, P. McGeehan, A. M. Meyers, C. N. Miller, C. A. Smith, W. W. K. Sparrow, H. L. Stevens, T. J. Strickler, G. E. Tebbetts, H. P. Treadway, H. von Unwerth, H. C. Westover, J. S. Worley. ***Macon.***—Le R. D. Williams. ***Pierce City.***—A. M. Vance. ***St. Joseph.***—F. R. Berry. ***St. Louis.***—A. A. Aegerter, J. H. Alexander, H. R. Andress, P. Aylett, G. S. Bergendahl, J. M. Bischoff, G. G. Black, H. E. Boardman, S. W. Bowen, C. W. Chassaing, F. D. Collins, R. S. Colnon, J. E. Conzelman, H. M. Cryder, E. C. Dicke, T. Ebashi, C. J. Eld, Jr., R. H. P. Ford, E. Gray, W. T. Gray, A. P. Greensfelder, O. F. Harting, V. K. Hendricks, F. A. Jones, A. E. Lindau, R. L. Lund, R. McCulloch, N. R. McLure, L. C. F. Metzger, R. Morey, A. T. North, J. M. Peters, H. J. Pfeifer, G. A. Pierce, C. L. Post, W. H. Prentice, Jr., J. C. Pritchard, J. L. Richmond, H. Rusch, J. W. Skelly, W. A. Tyrrell, F. L. Wilcox, S. L. Wonson. ***Webb City.***—W. E. Smith.

ASSOCIATES.—***St. Louis.***—E. C. Constance, H. von Schrenk.

JUNIORS.—***Carthage.***—D. N. Wetherell. ***Fruitville.***—L. L. Winans. ***Hermann.***—C. F. Phillips. ***Kansas City.***—C. A. Neal, H. F. Porter, L. B. Reynolds, R. M. Roberg, N. E. Waddell. ***Kirkwood.***—H. H. Clayton. ***New Florence.***—R. A. See. ***Poplar Bluff.***—A. W. Bushell. ***Rolla.***—F. E. Dennie. ***St. Joseph.***—H. Y. Gard. ***St. Louis.***—W. J. Burton, J. Cochran, A. P. Haney, F. C. Harper, W. W. Horner, C. P. Howes, W. J. Knight, M. Schuyler, W. P. Stewart, P. E. Tillit, H. C. T. Toensfeldt, J. W. Toms, F. J. Trelease, R. L. Williams.

MONTANA. Total Membership, 40.

MEMBERS.—***Butte.***—E. Carroll, W. H. Penfield, E. H. Wilson. ***Great Falls.***—S. B. Robbins, F. Scotten. ***Helena.***—M. H. Gerry, Jr., R. O. Hayt, H. N. Savage, J. B. Snow. ***Malta.***—G. O. Sanford. ***Missoula.***—F. Beckwith. ***Ronan.***—J. Wright. ***St. Ignatius.***—E. F. Tabor.

ASSOCIATE MEMBERS.—***Augusta.***—C. B. Long. ***Billings.***—C. E. Shipman. ***Fort Shaw.***—H. O. Beale, J. B. Bond, A. J. Hayes. ***Glendive.***—R. S. Stockton. ***Helena.***—E. C. Gersbach, C. E. Hayes, J. H. Hood, W. A. Lamb, R. M. Snell, G. E. Stratton. ***Huntley.***—C. D. Howe. ***Ridgelawn.***—G. L. Davis. ***St. Ignatius.***—A. J. Fisk, Jr. ***Valier.***—H. J. Saunders. ***Vandalia.***—L. H. Mitchell.

JUNIORS.—***Bonner.***—W. W. Mitchell. ***Fort Shaw.***—W. D. Trask. ***Glendive.***—R. T. Hurdle. ***Great Falls.***—C. E. Atwood. ***Helena.***—J. C. Beebe, B. E. Jones, F. Towle. ***Huntley.***—A. P. Smyth. ***Miles City.***—G. C. Pruett. ***St. Ignatius.***—L. D. Graham.

NEBRASKA. Total Membership, 25.

MEMBERS.—***Lincoln.***—F. T. Darrow, A. Dobson, W. Grant, G. S. Walsh. ***Omaha.***—G. L. Campen. ***South Omaha.***—W. S. King.

ASSOCIATE MEMBERS.—***Fall City.***—J. A. Crook. ***Fort Robinson.***—S. D. Rockenback. ***Mitchell.***—A. Weiss. ***Omaha.***—A. C. Arend, J. A. Bruce, G. J. S. Collins, G. W. Craig, H. A. Holdrege, A. C. Koenig, E. E. Larkins, R. A. Swartwout. ***York.***—W. J. Ryan.

JUNIORS.—***Alliance.***—F. C. Huntsman. ***Florence.***—J. A. Craven. ***Lincoln.***—H. P. Letton, D. D. Price. ***Omaha.***—H. Bortin, R. E. Mieth, R. B. Wright.

NEVADA. Total Membership, 8.

MEMBERS.—***Fallon.***—D. W. Cole. ***McGill.***—L. Duncan.

ASSOCIATE MEMBERS.—***Fallon.***—L. W. Hall. ***Hawthorne.***—L. B. Spencer. ***Reno.***—E. B. Bumsted, D. W. Hays, J. H. Manning, C. G. Tudor.

NEW HAMPSHIRE. Total Membership, 11.

MEMBERS.—***Derry Village.***—J. C. Chase. ***Hanover.***—R. Fletcher. ***Hill.***—G. Hodges. ***Little Boar's Head.***—W. H. Jaques. ***Portsmouth.***—L. E. Gregory.

ASSOCIATE MEMBERS.—***Berlin.***—G. F. Lovett. ***Hanover.***—C. A. Holden. ***Portsmouth.***—H. LeG. Hilton.

ASSOCIATES.—***Hanover.***—J. V. Hazen.

JUNIORS.—***Claremont.***—G. C. Tutherly. ***Whitefield.***—R. W. Hazen,

NEW JERSEY. Total Membership, 190.

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JUNIORS. ***Albany.***—R. D. Black, A. G. Chapman, H. J. Deutschbein, G. P. Graham, T. P. B. Kennedy, J. C. Peck, B. F. Vandervoort, G. E. Willcomb. ***Amsterdam.***—D. W. Overocker. ***Baldwinsville.***—A. C. Toll. ***Blasdell.***—P. D. Gillham. ***Bridge Hampton.***—W. H. Halsey. ***Brooklyn.***—A. E. Barlow, Jr., W. T. Chevalier, E. S. Closson, F. H. Densler, W. T. Derleth, F. J. Felgenhauer, H. E. Gill, R. H. Hammer, F. H. Munkelt, C. E. Ramser, L. Rome, J. Schmitt, C. J. Schumann, J. Smith, J. B. Van Vleck. ***Brown Station.***—J. F. Murphy. ***Buffalo.***—G. C. Brown, H. Chafetz, J. H. Feigel, J. T. Lillich, W. V. Scott. ***Cohoes.***—F. E. Reed. ***Cold Spring.*** C. F. Breitzke, C. M. Gould, G. A. Graham, R. W. Greenlaw. ***Cornwall-on-Hudson.***—E. T. King, S. M. Timberlake, L. C. Whittemore. ***Corona.***—J. D. Richardson. ***Croton.***—H. H. Cantwell. ***East Hampton.*** N. N. Tiffany. ***Elmira.***—H. A. Brainerd. ***Fairport.***—E. R. Bowerman. ***Flushing.***—A. C. Gregson, F. R. Howe, J. Upton. ***Fort Edward.***—H. Shoemaker. ***Freeport.***—A. S. Malcomson. ***Fulton.*** G. C. Andrews. ***Germantown.***—A. G. Volck. ***Gloversville.***—L. Wachtel. ***Hempstead.*** G. M. Estabrook. ***High Falls.***—H. M. Hale, J. P. Hogan, T. C. Mott, C. A. A. Steegmuller, H. L. Wittstein. ***Ithaca.***—R. P. Davis, H. McClure, A. P. Mills, C. L. Walker. ***Katonah.***—T. DeL. Coffin. ***Kingston.***—J. F. Loughran. ***Long Island City.***—W. J. Heiser. ***Massena.***—C. E. Stilson. ***Maybrook.***—B. Strain. ***Mechanicsville.***—F. S. Crowell, J. A. Galvin. ***Medina.***—R. H. Merrill. ***Middletown.***—C. H. Smith. ***Milliken.***—C. R. Chadwick. ***Mt. Vernon.***—F. M. Gaiger. ***New Brighton.***—W. L. Selmer. ***Newburgh.***—C. J. O'Donnell. ***New Paltz.***—A. R. Holbrook, E. H. Hopson, D. W. Howes. ***New Rochelle.***—G. E. Hoeft, H. S. Loughran, R. M. Wilson. ***New York City.****—J. S. Adey, W. J. Barney, F. B. Barshell, L. Bates, Jr., R. C. Becker, F. N. Benedict, O. G. Bennet, Jr., H. M. Bergman, C. L. Bogert, J. E. Boswick, J. L. Brennan, J. R. Breuchaud, A. E. Budell, W. A. Buell, O. G. H. Buettner, W. L. Cadwallader, E. C. Church, J. Clausnitzer, H. A. Cook, J. W. Cook, A. W. Coombs, C. H. Crooks, L. G. Cutler, N. B. de Forest, R. E. Dougherty, T. Eide, P. M. Entenmann, H. P. Farrington, W. D. Faucette, J. K. Finch, F. B. Forbes, W. F. Fox, W. E. Germer, J. H. Glander, Jr., J. W. Du B. Gould, C. A. Gross, E. P. Hamilton, H. P. Hamlin, E. F. Hammel, F. N. Hatch, C. E. Haywood, R. Hazen, A. B. Heiser, R. Hitt, B. B. Hodgman, R. T. Holloway, J. J. Hopper, R. H. Howes, H. C. Hutchins, D. C. Johnson, P. Jones, H. C. Kirkwood, L. Koenig, J. Lowry, Jr., L. H. Lubarsky, H. H. E. Lynn, F. S. MacIlvaine, R. W. McMullen, A. J. Mayell, E. J. Mehren, R. M. Merriman, J. C. Nelson, J. P. H. Perry, J. F. Porter, R. M. Riegel, C. S. Rindsfoos, H. W. Roberts, V. Roberts, A. J. Sackett, W. S. St. John, V. R. P. Saxe, G. P. Searight, L. J. Sieling, J. H. Small, Jr., E. G. Smith, L. I. Smoyer, H. C. Soest, W. H. Starr, N. A. Thayer, A. C. Tozzer, W. R. Tyler, J. R. Van Horne, H. L. Van Zile, H. C. Walton, E. A. Ward, G. M. Ward, K. Whitman, Jr., A. J. Willis, W. A. Yeo, A. J. Zabriskie. ***Olive Bridge.***—M. M. Farley. ***Oswego.***—L. W. Greene. ***Pleasantville.***—C. W. Banks. ***Potsdam.***—H. Miller. ***Poughkeepsie.***—H. A. Helling, G. W. Reese. ***Rhinebeck.***—F. C. Smith. ***Rochester.***—F. L. Bolton, F. J. Howes, W. J. Stewart, C. E. Tirrell. ***Rome.***—J. F. Greathead, W. F. Shaw. ***Schenectady.***—S. R. Bellows, L. C. Heilbronner, W. C. Taylor, W. E. Weller. ***Seneca Falls.***—W. B. Atwood. ***Stone Ridge.***—H. E. Barnes. ***Troy.***—C. D. Calkins, Le R. W. Clark, H. McM. Dibert, E. Littlefield, G. C. See, G. S. Thompson. ***Utica.***—C. E. Merritt. ***Vail Gate.***—A. P. Ackerman. ***Valhalla.***—E. L. Sprague, Jr. ***Walden.***—H. S. Harding, C. Lynde, F. Tingley. ***Wallkill.***—M. Stow. ***Watertown.***—L. B. Cleveland, A. W. Harrington. ***White Plains.***—H. C. Ellis, E. L. Lincoln, A. L. Sherman, H. D. Winsor, C. R. Wyckoff, Jr. ***Yonkers.***—J. S. Frazer, N. L. A. Malmros, G. L. Wentworth. ***Yorktown Heights.***—J. C. Gotwals, O. J. Swensson.

FELLOWS.—***Buffalo.***—J. J. Albright, H. A. Richmond. ***New York City.****—E. D. Adams, C. R. Flint, A. W. Kiddle, H. C. Meyer, J. R. Stanton. ***Rochester.***—C. M. Everest.

NORTH CAROLINA. Total Membership, 24.

MEMBERS.—***Asheville.***—C. E. Waddell. ***Chapel Hill.***—W. Cain. ***Charlotte.***—W. S. Lee, C. A. Mees. ***Clyde.***—W. H. Terrell. ***Newbern.***—H. T. Paterson. ***Rockingham.***—W. A. Leland. ***Wilmington.***—E. I. Brown. ***Winston-Salem.***—J. N. Ambler, J. L. Ludlow.

ASSOCIATE MEMBERS.—***Burlington.***—L. R. Whitted. ***Charlotte.***—B. S. Drane, J. Firth. ***Durham.***—J. W. Pierce, G. C. White. ***Greensboro.***—J. M. Bandy, E. W. Myers. ***Washington.***—L. G. Berry. ***Wilmington.***—C. L. B. Anderson, D. W. Gross, H. deW. Rapalje.

JUNIORS.—***Charlotte.***—J. G. Moore. ***Newbern.***—W. Mahone, Jr. ***West Raleigh.***—R. I. Poole.

NORTH DAKOTA. Total Membership, 2.

MEMBERS.—***Mandan.***—P. E. Thian.

ASSOCIATE MEMBERS.—***University.***—E. F. Chandler.

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* Includes the Boroughs of Manhattan and the Bronx.

OHIO. Total Membership, 169.

MEMBERS.—***Akron.***—C. E. Perkins. ***Canton.***—L. E. Chapin, E. J. Landor. ***Chardon.***—J. F. LeBaron. ***Cincinnati.***—F. H. Alfred, W. P. Anderson, W. Archer, W. Baldwin, M. D. Burke, J. A. Fox, J. W. Hill, H. Jervey, W. C. Jewett, H. M. Knapp, C. S. Millard, J. C. Oakes, B. F. Thomas, J. Tuthill, C. A. Wilson. ***Cleveland.***—W. Beahan, F. E. Bissell, W. P. Brown, W. J. Carter, C. H. Clark, F. A. Coleman, J. M. Estep, J. W. Frazier, H. Fuller, B. L. Green, W. O. Henderer, A. J. Himes, R. Hoffmann, C. P. Howard, A. W. Johnston, M. W. Kingsley, B. R. Leffler, F. W. Lepper, F. W. Lovell, J. Millis, W. K. Monroe, J. E. A. Moore, A. Mordecai, B. F. Morse, F. C. Osborn, J. T. P. Pardee, W. P. Rice, F. D. Richards, J. Ritchie, S. Rockwell, C. P. Ruple, R. E. Sheal, J. C. Spencer, E. M. Sprague, C. Staley, G. H. Tinker, G. R. Wadsworth, W. J. Watson, C. H. Wright, A. W. Zesiger. ***Columbus.***—E. G. Bradbury, F. L. Chase, F. H. Eno, J. Griggs, C. T. Morris, E. G. Robinson. ***Dayton.***—H. E. Talbott. ***East Liverpool.***—W. R. W. Griffin. ***Elyria.***—W. H. Searles. ***Glendale.***—H. H. Shepard. ***Martins Ferry.***—J. Blodgett. ***Mt. Vernon.***—I. M. Wolverton. ***Sandusky.***—C. A. Judson. ***Springfield.***—G. Thompson. ***Toledo.***—W. T. Blunt, J. E. Ferguson, C. L. Gates, G. A. Gessner, Jr., G. V. Rhines, H. E. Riggs, M. J. Riggs, W. J. Sherman. ***Washington Court House.***—R. C. Hunt. ***Wauseon.***—G. E. Howe. ***Wellston.***—E. D. Wickes. ***Zanesville.***—J. K. Geddes.

ASSOCIATE MEMBERS.—***Akron.***—L. P. Winterhalter. ***Bellefontaine.***—T. W. Hill. ***Bridgeport.***—J. A. Donahey. ***Canton.***—G. M. Demorest. ***Chillicothe.***—F. P. Turner. ***Cincinnati.***—F. E. Ayer, J. E. Barlow, G. H. Gilbert, T. Green, J. A. Hiller, H. C. Innes, E. O. Keator, C. A. Paquette, H. Schneider, C. S. Sheldon, J. Stewart, H. W. Vehrenkamp. ***Circleville.***—O. W. Stiles. ***Cleveland.***—H. E. Baldwin, E. W. Cunningham, A. M. Currier, P. P. Evans, J. E. Grady, A Gravelle, C. W. Lundoff, L. H. Miller, F. H. Neff, E. H. Owen, F. A. Pease, J. H. Roach, C. W. Schubert, E. B. Thomas, H. S. Williams. ***Columbus.***—P. Burgess, A. L. Giles, R. S. Jones, N. D. Monsarrat. ***Elyria.***—E. J. Crisp. ***Fairport Harbor.***—G. S. Meek. ***Hamilton.***—R. T. Robinson. ***Jefferson.***—J. S. Matson. ***Lakewood.***—J. R. Poe. ***Little Hocking.***—C. J. Rannells. ***Mansfield.***—L. A. Keith. ***Massillon.***—M. C. Bland. ***Mt. Vernon.***—C. G. Conley. ***Norwood.***—N. O. Goldsmith. ***Sandusky.***—C. M. King, S. B. Newberry. ***Toledo.***—L. M. Gram, C. O. Lasley, P. J. Reich, G. Scott, A. H. Smith, F. N. Spencer. ***Youngstown.***—J. Hunter. ***Zanesville.***—H. F. Frye, E. B. Taylor, Jr.

ASSOCIATES.—***Cincinnati.***—R. Anderson. ***Cleveland.***—E. M. Graves. H. W. King, R. H. Lee, W. P. Palmer, C. B. Stowe. ***Columbus.***—D. W. Brooks, W. R. Copeland. ***Dayton.***—D. H. Morris.

JUNIORS.—***Cincinnati.***—O. E. Selby, G. Warner. ***Cleveland.***—W. W. Huff, O. W. Irwin, H. W. Maynard, K. H. Osborn. ***Columbus.***—W. H. Dittoe, R. W. Ferris. ***Genoa.***—R. M. Strohl. ***Hamilton.***—R. B. Stanton, Jr. ***Hudson.***—L. Ellsworth. ***Jefferson.***—H. F. Bell. ***Mt. Vernon.***—J. R. Brooks. ***Steubenville.***—A. P. Holloway. ***Toledo.***—W. G. Clark, H. C. McClure. ***Youngstown.***—C. J. Paterson.

OKLAHOMA. Total Membership, 18.

MEMBERS.—***Mill Creek.***—J G. Bloom. ***Oklahoma.***—H. V. Hinckley. ***Purcell.***—F. C. Hand. ***Shawnee.***—F. D. Brown.

ASSOCIATE MEMBERS.—***Bartlesville.***—A. J. McNeil. ***Chandler.***—P. M. Speicher. ***Clinton.***—J. L. O'Hearn. ***Davis.***—A. C. Polk. ***Muskogee.***—E. M. Graham, D. D. Smith. ***Oklahoma.***—W. L. Benham, C. M. Pritchard. ***Stilwell.***—F. E. Estes.

JUNIORS.—***Muskogee.***—C. Schultz. ***Nowata.***—A. P. Learned. ***Oklahoma.***—W. E. Price, F. M. Terry. ***Wagoner.***—J. W. Currey.

OREGON. Total Membership, 83.

MEMBERS.—***Ashland.***—F. A. Walker. ***Bull Run.***—J. B. Goodwin. ***Cottage Grove.***—A. B. Wood. ***Klamath Falls.***—W. W. Patch. ***Medford.***—W. Gerig. W. J. Roberts. ***Natron.***—H. I. Randall. ***Pokegama.***—E. T. Abbott. ***Portland.***—C. Andersen, W. G. Brown, D. D. Clarke, F. W. Conn, J. H. Cunningham, F. I. Fuller, W. H. Graves. G. B. Hegardt, D. C. Henny, W. E. Herring, F. Hesse, E. G. Hopson, J. Q. Jamieson, G. W. Lilly, G. C. Mason, J. J. Morrow, J. P. Newell, E. W. Paget, W. R. Phillips, J. S. Polhemus, M. E. Reed, A. F. Sears, O. E. Stanley, J. F. Stevens, E. A. Taylor, E. B. Thomson, W. R. Weidman, J. T. Whistler. ***The Dalles.***—G. E. Goodwin, F. C. Schubert.

ASSOCIATE MEMBERS.—***Astoria.***—C. N. Bennett. ***Big Eddy.***—G. A. Sisson. ***Cascade Locks.***—C. W. Thompson. ***Cazadero.***—S. C. Hulse. ***Celilo.***—H. M. Harps. ***Cottage Grove.***—R. E. Griswold. ***Eagle Point.***—T. F. Boltz. ***Eugene.***—F. G. Frink. ***Hermiston.***—H. D. Newell. ***Lakeview.***—G. W. Rice. ***Marshfield.***—F. E. Leete. ***Portland.***—W. W. Amburn, J. G. Beach, R. Chase, W. D. Clarke, R. H. Corey, R. G. Dieck, R. L'A. Donald, J. A. Fouilhoux, G. A. Kyle, O. Laurgaard, E. B. MacNaughton, C. J. McGonigle, E. Montgomery, H. E. Plummer, C. W. Raynor, J. A. Sargent, D. H. Sawyer, J. C. Stevens, G. Stubblefield. ***Salem.***—J. H. Lewis. ***The Dalles.***—L. C. F. Balz.

ASSOCIATES.—***Portland.***—J. A. Currey.

JUNIORS.—***Portland.***—H. C. Ackemann, L. A. Andrus, H. B. Coburn, Jr., R. W. Davenport, T. M. Goodrich, C. J. Green, G. Haselton, C. E. Hickok, E. C. Weaver, H. L. Wiley, C. W. Woodruff, R. C. Wygant.

PENNSYLVANIA. Total Membership, 488.

HONORARY MEMBERS.—***Bethlehem.***—J. Fritz. ***Philadelphia.***—G. W. Melville.

MEMBERS.—***Allentown.***—H. F. Bascom, L. J. H. Grossart, C. A. Matcham. ***Altoona.***—H. Linton. ***Ambridge.***—R. M. Greene, R. G. Manning. ***Athens.***—C. Kellogg, C. S. Maurice. ***Bangor.***—C. Albertson. ***Beaver Falls.***—C. M. Emmons, C. H. Vaughan, T. S. White. ***Bellevue.***—W. Martin. ***Braeburn.***—G. H. Neilson. ***Brownsville.***—J. B. Bott. ***Carbondale.***—C. L. Rowland. ***Columbia.***—E. E. Haslam. ***Connellsville.***—J. B. Hogg. ***Cornwall.***—H Souder. ***Crafton.***—J. S. Haring. ***East Downingtown.***—R. I D. Ashbridge. ***Easton.***—H. R. Fehr, F. Firmstone, J. M. Sherrerd. ***Erie.***—B. E. Briggs, J. W. Hughes, J. Supplee. ***Glenshaw.***—F. L. Garlinghouse. ***Greenville.***—W. S. McFetridge, H. T. Porter. ***Harrisburg.***—G. W. Ensign, G. H. Maurice, M. D. Pratt, F. H. Snow. ***Huntingdon.***—J. M. Africa. ***Jenkintown.***—J. W. Hunter. ***Johnstown.***—C. E. Curtis, E. F. Kenney, G. E. Thackray. ***Lancaster.***—J. B. Rohrer. ***Lansford.***—B. Snyder, Jr., W G. Whildin. ***Malvern.***—W. J. Nicolls. ***Mauch Chunk.***—J. Ruddle. ***Meadville.***—W. A. Doane. ***Monongahela.***—DeW. P. Pugh. ***New Castle.***—R. G. Hengst, W. G. Price. ***Philadelphia.***—F. W. Abbott, W. A. Aiken, D. G. Anderson, C. C. Anthony, W. W. Atterbury, W. F. Ballinger, L. F. Bellinger, G. P. Bland, A. Bonzano, C. P. Bower, P. F. Brendlinger, H. T. Campion, J. Christie, R. C. Clarkson, F. H. Clement, W. W. Cole, J. F. Cullen, G. E. Datesman, E. F. Dawson, R. G. Develin, C. Dillenbeck, F. C. Dunlap, M. W. Easby, W. Easby, Jr., T. N. Ely, S. E. Fairchild, Jr., R. Farnham, Jr., W. H. Ford, B. Franklin, W. C. Furber, F. L. Garrison, J E. Gibson, H. T. Grantham, C. W. Haines, S. Harris, E. P. H. Harrison, J. F. Hasskarl, L. M. Haupt, I. W. Hubbard, R. L. Humphrey, W. Hunter, A. S. Kibbe, P. S. King, F. C. Kunz, B. B. Lathbury, H. W. Latta, J. W. Ledoux, H. R. Leonard, H. F. Lofland, D. J. Lucas, T. C. McCollom, H. McKay, E. Marburg, C. F. Mebus, S. P. Mitchell, W. A. Moncure, H. G. Morris, J. F. Murray, J. C. Patterson, C. P. Perkins, M. R. Pugh, H. H. Quimby, C. W. Raymond, S. Rea, D. Reeves, J. T. Richards, W. B. Riegner, S. H. Rippey, P. Roberts, Jr., P. M. Sax, C. C. Schneider, H. A. Schofield, E. M. Scofield, G. M. Scofield, E. F. Smith, H. C. Smith, J. S. Smith, H. R. Stanford, J. T. Stuart, C. A. Sundstrom, S. M. Swaab, J. E. Swanker, E. B. Temple, J. H. Terry, R. Thayer, E. D. Thompson, J. A. Vogleson, I. W. von Leer, T. Voorhees, J. C. Wagner, S. T. Wagner, W. L. Webb, G. S. Webster, W. R. Webster, J. E. Whitfield, D. H. Whitmer, H. W. Wilson, P. H. Wilson, L. R. Zollinger. ***Phœnixville.***—J. S. Deans. ***Pittsburg.***—L. J. Affelder, J. A. Atwood, H. W. Baker, G. P. Baldwin, B. A. Behrend, E. M. Bigelow, J. C. Bland, H. R. Blickle, L. P. Blum, W. C. Boyd, W. Bradford, N. F. Brown, J. N. Chester, E. W. Crellin, R. A. Cummings, W. C. Cushing, G. S. Davison, P. Didier, E. S. Fickes, F. E. Field, J. M. Floesch, E. Gerber, G. A. Gilfillan, E. Godfrey, N. M. Hench, N. F. Hopkins, T. H. Johnson, W. M. Judd, H. F. Juengst, W. H. Kennedy, R. Khuen, J. H. Klinck, R. W. Knight, M. Knowles, H. Laub, H. F. Layton, J. K. Lyons, A. B. McGrew, D. W. McNaugher, E. K. Morse, J. C. Neale, C. M. Neeld, J. N. Ostrom, O. R. Pihl, H. S. Prichard, A. R. Raymer, T. Rodd, F. G. Ross, H. B. Rust, W. L. Scaife, A. L. Schultz, L. H. Shoemaker, G. H. Simpson, N. S. Sprague, T. A. Straub, C. Strong, E. Swensson, B. H. Taylor, E. B. Taylor, S. A. Taylor, S. La R. Tone, J. W. Walker, E. F. Wendt, G. Westinghouse, W. Whited, F. Wilcox, T. J. Wilkerson, W. G. Wilkins, H. M. Wilson, P. L. Wölfel, J. Wood, R. B. Woodworth, C. L. Wooldridge. ***Reading.***—E. L. Nuebling, F. S. Stevens. ***Ridgway.***—H. B. Norton. ***Scranton.***—W. McK. Marple, W. A. May, C. C. Rose. ***South Bethlehem.***—G. H. Blakeley, A. L. Colby, F. P. McKibben, F. E. Schall, C. E. Webster, W. L. Wilson. ***State College.***—E. D. Walker. ***Steelton.***—C. A. Alden, F. W. Cohen, T. Earle, L. E. Johnson, C. H. Mercer, J. V. W. Reynders. ***Sunbury.***—G. B. Nauman. ***Susquehanna.***—O. F. Barnes. ***Swarthmore.***—A. Beardsley. ***Swissvale.***—G. R. Harlow. ***Tyrone.***—A. E. Bachert. ***Uniontown.***—W. O. White. ***Vintondale.***—S. K. Smith. ***Warren.***—De F. A. Wheelock. ***Wilkes-Barre.***—R. V. A. Norris, H. S. Smith. ***Wilkinsburg.***—C. G. Frosell, W. C. Hawley. ***Williamsport.***—S. T. Hayt, Jr.

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RHODE ISLAND. Total Membership, 49.

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ASSOCIATE MEMBERS.—***Pawtucket.***—R. DeW. Havens. ***Providence.***—W. L. Anthony, H. W. Ballou, N. D. Benson, H. B. Drowne, G. F. Hosmer, S. F. Nolan, L. H. Peabody, Jr., P. S. Perkins, W. B. Wood. ***Westerly.***—T. McKenzie.

JUNIORS.—***Central Falls.***—G. E. Burnham. ***Middletown.***—C. H. Ward, 2d. ***Newport.***—A. M. Chace. ***Pawtucket.***—H. F. Esten. ***Providence.***—M. H. S. Affleck, H. B. Edmundson, C. M. Hathaway, H. E. Miller, I. W. Patterson, O. W. Rackle, H. A. Sweetland, E. W. Wall, J. Wilmot.

SOUTH CAROLINA. Total Membership, 19.

MEMBERS.—***Charleston.***—J. P. Allen. ***Columbia.***—J. McNeal, G. E. Shand, C. C. Wilson. ***Georgetown.***—R. Whitford. ***Greenville.***—P. M. Feltham, J. E. Sirrine. ***Spartanburg.***—W. B. W. Howe.

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ASSOCIATES.—***Charleston.***—J. M. Diven.

JUNIORS.—***Abbeville.***—W. L. Hemphill.

SOUTH DAKOTA. Total Membership, 10.

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JUNIORS.—***Aberdeen.***—R. B. Easton.

TENNESSEE. Total Membership, 50.

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JUNIORS.—***Chattanooga.***—H. B. W. Howie, C. A. Lyerly, Jr., P. L. Pierce.

TEXAS. Total Membership, 90.

MEMBERS. ***Altura.***—W. G. Russell. ***Austin.***—T. U. Taylor. ***Beaumont.***—C. L. Scherer. ***China.***—C. W. Rollins. ***College Station.***—J. C. Nagle. ***Corsicana.***—H. G. Johnston. ***Dallas.***—H. E. Arthur, C. H. Chamberlin. O. H. Lang, O. Shanks, R. C. Smead, B. S. Wathen. ***El Paso.***—J. L. Campbell, W. W. Follett. M. Morris, Jr., W. M. Reed, F. H. Todd. ***Fort Worth.***—J. B. Hawley, W. B. King. ***Galveston.*** E. M. Hartrick, G. P. Howell, W. P. Parker, L. W. Stubbs. ***Houston.***—W. M. Archibald, C. Blake, E. B. Cushing, J. M. Howe, H. F. Jonas. ***Houston Heights.***—E. J. Nichols. ***San Antonio.***—R. H. Gresham, F. C. Woermann. ***Terrell.***—L. W. Wells. ***Wichita Falls.***—R. A. Thompson.

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JUNIORS.—***Austin.***—S. P. Finch, R. G. Tyler. ***Corpus Christi.***—C. F. K-M. von Blücher. ***Dallas.***—R. L. Holmes, W. J. Powell. ***Eagle Lake.***—A. P. Rollins. ***El Paso.***—C. P. Chester. ***Ennis.*** D. E. Pendleton. ***Fort Worth.***—J. K. Grannis, A. C. Kellersberger. ***Galveston.*** N. T. Blackburn. C. F. Bornefeld. C. M. Davis. ***Houston.***—C. J. Howard, J. L. Jacobs. ***Lockhart.***—E. M. Thomson. ***Ovalo.***—J. M. Warner. ***Pecos.***—L. W. Anderson. ***San Antonio.***—I. O. Gibble. ***Stamford.***—J. W. Paret.

UTAH. Total Membership, 37.

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VERMONT. Total Membership, 7.

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VIRGINIA. Total Membership, 71.

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JUNIORS.—***Bandy.***—T. J. Wright. Jr. ***Norfolk.***—H. V. Joslin. ***Richmond.***—H. R. Messer. ***Roanoke.***—R. L. Lindsay. ***Yorktown.***—W. D. Cater.

WASHINGTON. Total Membership, 127.

MEMBERS.—***Bellingham.***—J. J. Donovan. ***Bremerton.***—E. H. Brownell, F. W. D. Holbrook. ***East Sound.***—J. B. C. Lockwood. ***Ellensburg.***—E. H. Baldwin. ***Fort Casey.***—S. D. Mason. ***Mt. Vernon.***—C. G. Darrach. ***North Yakima.***—E. M. Kenly, T. A. Noble. ***Richmond Beach.***—M. Chase. ***Seattle.***—J. P. Badenhausen, H. M. Chittenden, J. M. Clapp, B. D. Dean, A. H. Dimock, A. S. Downey, C. E. Fowler, A. H. Fuller, J. L. Hall, S. H. Hedges, E. B. Hussey, J. Jacobs, C. W. Kutz, J. D. MacVicar, E. J. McCaustland, D. W. McMorris, A. W. Münster, R. H. Ober, H. K. Owens, E. J. Pearson, A. O. Powell, W. B. Ruggles, R. H. Thomson. ***Spokane.***—A. A. Booth, O. S. Bowen, G. R. G. Conway, T. H. Croswell, A. G. Holt, U. B. Hough, A. McC. Lupfer, C. S. MacCalla, S. A. McCoy, P. Mogensen, W. E. Moore, F. L. Pitman, J. C. Ralston, B. C. Riblet, F. McC. Sylvester. ***Sumner.***—W. P. Wood. ***Sunnyside.***—E. McCulloh, I. Watson. ***Tacoma.***—B. L. Crosby, H. A. Hall. ***Toppenish.***—J. W. Martin.

ASSOCIATE MEMBERS.—***Bellingham.***—E. C. Macy. ***Blaine.***—E. B. Day. ***Centralia.***—C. De LaP. Atterbury, L. S. Oakes, P. A. G. Tilmont. ***Chehalis.***—R. L. Alexander, W. H. Allen. ***Ellensburg.***—La V. J. Charles. ***Fort Flagler.***—J. C. Phillips. ***Kenmore.***—B. E. Corlett. ***Leavenworth.***—A. H. Sylvester. ***Mabton.***—C. B. Cox. ***Olympia.***—H. L. Gray. ***Seattle.***—H. J. M. Baker, M. H. Brinkley, H. D. Bruning, C. B. Lamont, J. L. Lee, T. P. Moorehead, C. C. More, S. Murray, A. T. Nelson, S. B. Phillips, C. H. Reeves, H. R. Robbins, A. W. Sargent, H. H. Wolff. ***Spokane.***—A. D. Butler, M. A. Butler, F. L. Copeland, W. H. Fisher, D. Hays, E. A. Keys, T. J. Klossowski, M. Macartney, W. H. Phillips, G. L. Sawyer. ***Sumner.***—A. A. Northrop. ***Sunnyside.***—E. A. Moritz. ***Tacoma.***—C. L. Creelman, C. F. Healey, J. E. Moody, S. Sims. ***Twisp.***—W. D. Sample. ***Vancouver.***—E. J. Dent. ***Wapato.***—J. H. Best. ***Wenatchee.***—J. W. Sussex, C. C. Ward.

JUNIORS.—***Bremerton.***—H. F. Scholtz, H. E. Squire. ***Fort Ward.***—P. H. Ottosen. ***Hadlock.***—J. C. F. Shafer. ***Lyle.***—F. A. Kittredge. ***Monroe.***—D. R. Weber. ***Olympia.***—J. C. Rathbun. ***Pullman.***—W. C. Willard. ***Seattle.***—C. D. Ashbrook, H. N. Bishop, C. L. Dimmler, H. E. Forsyth, H. M. Hadley, R. H. Jones, W. Lewis, T. G. McCrory, F. M. Smith, J. B. Warrack. ***Spokane.***—J. W. Cunningham, C. H. Jabelonsky, W. Le R. Malony, R. J. Schmid. ***Sumner.***—V. H. Garvey. ***Sunnyside.***—W. L. Rowe. ***Wellington.***—L. R. Smith, Jr.

WEST VIRGINIA. Total Membership, 36.

MEMBERS.—***Berkeley Springs.***—B. S. Randolph. ***Bluefield.***—S. H. Meem. ***Charleston.***—S. P. Baird, A. M. Scott. ***Clarksburg.***—D. D. Britt, T. M. Jackson. ***Eccles.***—W. A. Allen. ***Elkins.***—J. F. Healy. ***Gary.***—H. N. Eavenson. ***Morgantown.***—S. D. Brady. ***New Cumberland.***—C. E. Grafton. ***Parkersburg.***--W. McL. Hall. ***Wellsburg.***—F. D. Holbrook. ***Wheeling.***—F. B. Duis, F. A. Hastings, J. A. McDonough. ***Welch.***—J. A. Davenport.

ASSOCIATE MEMBERS.—***Bluefield.***—G. Dunglinson, Jr., J. L. Morrison. ***Charleston.***—R. P. Black. ***Clarksburg.***—G. M. Bassell, J. R. McClintock. ***Fraziers Bottom.***—C. E. McCoy. ***Gary.***—J. Taylor, Jr. ***Huntington.***—F. O. Renshaw. ***Morgantown.***—W. H. Boughton. ***Parkersburg.*** J. P. Horstman. ***Princeton.***—C. R. Hawley. ***Stanaford.***—C. M. Binford. ***Wheeling.***—F. W. Altstaetter, G. B. Bebout, W. N. Dambach, R. Hazlett.

ASSOCIATES.—***Charleston.***—W. D. Sell.

JUNIORS.—***Princeton.***—H. E. Hines. ***Wheeling.***—J. Shema.

WISCONSIN. Total Membership, 42.

HONORARY MEMBERS.—***Milwaukee.***—D. J. Whittemore.

MEMBERS.—***Berlin.***—E. L. Walker. ***La Crosse.***—W. A. Thompson. ***Madison.***—D. W. Mead, W. D. Pence. ***Milwaukee.***—G. H. Benzenberg, W. F. Carr, R. E. Newton, C. J. Poetsch, W. J. Sando. ***Reserve.***—G. M. Huss.

ASSOCIATE MEMBERS.—***Appleton.***—D. C. Trott. ***De Pere.***—G. P. Hawley. ***Grantsburg.***—H. J. Wild. ***Madison.***—G. J. Davis, Jr., C. M. Larson, W. E. Miller, C. V. Seastone, L. S. Smith, C. B. Stewart, C. Thuringer, F. E. Turneaure, C. R. Weidner, C. P. Winslow. ***Mayville.***—A. F. Plock. ***Milwaukee.***—A. C. Bell, L. E. Bogen, J. C. Davis, J. F. Jackson, L. D. Williams. ***South Milwaukee.***—W. M. Rosewater. ***Waukesha.***—P. Sawyer.

ASSOCIATES.—***North Milwaukee.***—T. R. Brown.

JUNIORS.—***Madison.***--F. W. Doolittle, R. M. Feustel, J. G. Hirsch, L. P. Jerrard. ***Milwaukee.***--S. A. Greeley, G. E. Kahn, G. C. Newton. ***Sparta.***—G. Kingsley.

FELLOWS.—***Milwaukee.***—S. M. Green.

WYOMING. Total Membership, 14.

MEMBERS.—***Cheyenne.***—H. B. Patten. ***Evanston.***—W. Newbrough. ***Laramie.***—R. D. Stewart. ***Powell.***—C. P. Williams. ***Sheridan.***—E. Gillette.

ASSOCIATE MEMBERS.—***Cheyenne.***—F. G. Skinner. ***Eden.***—W. G. Dow. ***Germania.***—G. W. Zorn. ***Moran.***—F. T. Crowe. ***Pathfinder.***—H. D. Comstock. ***Powell.***—L. R. Balch. ***Sheridan.***—E. L. Clarke. ***Wahaba.***—M. DeT. Kelley. ***Wheatland.***—J. C. Hadsall.

CENTRAL AMERICA.

COSTA RICA. Total Membership, 3.

MEMBERS.—***Guapiles.***—P. W. Chamberlain. ***San José.***—L. Matamoros.

JUNIORS.—***Limon.***—N. Benedict.

HONDURAS. Total Membership, 1.

ASSOCIATE MEMBERS.—***Ceiba.***—D. J. Linard.

NICARAGUA. Total Membership, 1.

MEMBERS.—***Managua.***—J. C. Wiest.

PANAMA. Total Membership, 42.

MEMBERS.—***Corozal.***—H. O. Cole, J. M. G. Watt, S. B. Williamson. ***Cristobal.***—H. Hardy. ***Culebra.***—L. D. Cornish, G. W. Goethals, H. Goldmark, H. F. Hodges, T. E. L. Lipsey, C. M. Saville, E. C. Sherman, W. L. Sibert. ***Empire.***—A. S. Zinn. ***Gatun.***—C. Harding, J. P. Jervey, L. L. Jewel, H. W. Stickle, G. M. Wells. ***Panama.***—R. M. Arango. J. G. Holcombe.

ASSOCIATE MEMBERS.—***Bocas del Toro.***—A. G. Robertson. ***Bohio.***—R. W. Hebard. ***Corozal.***—A. R. James, W. Rowland. ***Cristobal.***—F. Mears, C. Nixon, F. C. Stanton. ***Culebra.***—T. B. Mönniche, H. H. Rousseau, H. F. Tucker, R. R. Wiggins. ***Gatun.***—A. Awoyama, C. P. Fortney, N. M. Johnson. ***Las Cascadas.***—W. D. Stanton.

JUNIORS.—***Ancon.***—O. E. Malsbury. ***Balboa.***—W. J. Spalding. ***Corozal.***—H. W. Bluhm. ***Culebra.***—A. R. Brown, J. G. Steese, A. I. Stiles. ***Gatun.***—A. Richards.

SOUTH AMERICA.

ARGENTINE REPUBLIC. Total Membership, 12.

MEMBERS.—***Bahia Blanca.***—C. Anthony, Jr. ***Buenos Aires.***—W. L. Brown, A. B. Lea, C. Wauters. ***Colonia Alvear.***—G. A. Lange. ***La Calera.***—C. C. Lewis.

ASSOCIATE MEMBERS.—***Bahia Blanca.***—H. Williamson. ***Buenos Aires.***—A. A. Agramonte, C. L. Nelson, P. Smith. ***Mendoza.***—J. J. Corti.

JUNIORS.—***Mendoza.***—H. L. Miller.

BOLIVIA. Total Membership, 3.

MEMBERS.—***La Paz.***—J. Pierce-Hope.

ASSOCIATE MEMBERS.—***Oruro.***—W. L. Gibson.

JUNIORS.—***Oruro.***—J. H. Frazer.

BRAZIL. Total Membership, 16.

MEMBERS.—***Manãos.***—J. Y. Bayliss, H. F. Dose, J. M. Robinson. ***Rio de Janeiro.***—J. A. dos Santos, W. G. McConnel, H. C. Ripley. ***Santos.***—W. Huggins. ***São Paulo.***—V. da Silva Freire, W. N. Walmsley.

ASSOCIATE MEMBERS.—***Bello Horizonte.***—L. Baeta-Neves. ***Manaos.***—S. S. Bunker, R. B. Manter. ***Rio de Janeiro.***—J. Pires do Rio, T. P. Stevenson, Jr.

JUNIORS.—***Manãos.***—E. B. Karnopp. ***Porto Velho.***—F. S. Weston.

CHILI. Total Membership, 5.

MEMBERS.—***Santiago.***—R. W. Hornsby, J. Tonkin Thomas. ***Valparaiso.***—E. B. Budge.

ASSOCIATE MEMBERS.—***Concepcion.***—J. Du Bois. ***Santiago.***—W. B. Leane.

COLOMBIA. Total Membership, 4.

MEMBERS.—***Bogota.***—G. A. Ritchie. ***Cali.***—R. A. Sálas.

ASSOCIATE MEMBERS.—***Cali.***—H. J. Eder. ***Girardot.***—A. de la Torre.

ECUADOR. **Total Membership, 1.**

MEMBERS.—***Guayaquil.***—A. S. Hobby.

PERU. **Total Membership, 7.**

MEMBERS.—***Arequipa.***—T. A. Corry. ***Lima.***—A. B. Bentzon.

ASSOCIATE MEMBERS.—***Arequipa.***—J. A. Arce. ***Chimbote.***—J. H. Burgoyne, Jr. ***Lima.***—R. Ferradas. ***Trujillo.***—C. W. Sutton.

JUNIORS.—***Lima.***—F. Carbajal.

URUGUAY. **Total Membership, 1.**

ASSOCIATE MEMBERS.—***Montevideo.***—V. B. Sudriers.

WEST INDIA ISLANDS.

CUBA. **Total Membership, 46.**

MEMBERS.—***Camagüey.***—S. F. Shaw. ***Ceballos.***—P. B. Windsor. ***Guantanamo.***—C. L. Carpenter. ***Havana.***—T. T. Allard, J. F. Case, M. A. Coroalles, F. L. Getman, D. E. McComb, E. W. McCormack, J. A. McNicol, M. A. Smith. ***Matanzas.***—Y. Polledo. ***Santiago de Cuba.***—E. J. Chibas.

ASSOCIATE MEMBERS.—***Calimete.***—P. A. Suarez y Cordoves. ***Camagüey.***—J. M. Farrin, N. P. Turner. ***Felton.***—A. C. Reed. ***Firmeza.***—B. L. Cushing, A. W. Gaumer, E. M. Holmes. ***Havana.***—J. M. Babé, C. C. FitzGerald, T. Frasquieri y Regueifero, T. L. Huston, H. E. Hyde, C. E. Martinez y Reugifo, A. E. Mesa, F. A. Snyder, J. R. Villalon. ***Sagua la Grande.***—W. A. Hunicke, G. P. Morrill, E. R. Williams. ***Santa Clara.***—G. G. Fischer. ***Santiago de Cuba.***—S. A. Barratt, G. W. Pfeiffer.

JUNIORS.—***Felton.***—W. H. McCandliss. ***Guantanamo.***—G. C. Peterson. ***Havana.***—G. A. Dubois, R. S. Giquel, J. J. Manzanilla y Carbonell, R. A. Martinez, H. H. Rennell, R. J. Torralbas, M. Villa, R. S. Webster. ***Santiago de Cuba.***—J. D. Montero.

DOMINICA. **Total Membership, 1.**

ASSOCIATE MEMBERS.—***Canefield.***—A. H. Green.

JAMAICA. **Total Membership, 3.**

MEMBERS.—***Kingston.***—C. J. Thornton.

ASSOCIATE MEMBERS.—***Kingston.***—J. H. Dodd. ***Richmond.***—J. M. Fletcher.

PORTO RICO. **Total Membership, 12.**

MEMBERS.—***Guayama.***—J. W. Beardsley, W. W. Schlecht. ***Ponce.***—M. V. Domenech, V. A. Harris. ***San Juan.***—J. A. Canals.

ASSOCIATE MEMBERS.—***Central Aguirre.***—F. Pace. ***Guayama.***—J. M. Giles. ***Juana Diaz.***—L. V. N. Branch, W. E. Hall. ***San Juan.***—C. del Valle Zeno.

JUNIORS.—***Patillas.***—O. Y. Leonard. ***Ponce.***—M. J. Backus.

SANTO DOMINGO. **Total Membership, 5.**

MEMBERS.—***Santo Domingo.***—W. H. Balch, H. F. D. Burke, J. L. Mann.

ASSOCIATE MEMBERS.—***Santo Domingo.***—L. M. Huntington.

JUNIORS.—***Santo Domingo.***—J. H. Stone.

TRINIDAD. **Total Membership, 1.**

ASSOCIATE MEMBERS.—***Port of Spain.***—L. J. Proctor.

EUROPE.

AUSTRIA. Total Membership, 4.

MEMBERS. ***Vienna.***—M. de T. e Argollo, C. Redlich, F. E. von Emperger, E. A. Ziffer.

DENMARK. Total Membership, 2.

MEMBERS.—***Charlottenlund.***—M. I. Nyeboe.

ASSOCIATE MEMBERS.—***Aarhus.***—H. T. Forchhammer.

FRANCE. Total Membership, 7.

CORRESPONDING MEMBERS.—***Paris.***—E. Pontzen.

MEMBERS.—***Nice.***—J. H. Johnston. ***Paris.***—E. Budge, J. H. Pope, P. A. Seurot.

ASSOCIATE MEMBERS.—***Paris.***—S. D. Brown, A. L. Jacobson.

GERMANY. Total Membership, 5.

CORRESPONDING MEMBERS.—***Hamburg.***—C. O. Gleim.

MEMBERS.—***Cologne.***—F. W. Lehnartz. ***Deutsch-Eylau.***—R. Bassel. ***Dresden.***—G. W. Gehler.

ASSOCIATE MEMBERS.—***Berlin.***—A. Jordahl.

GREAT BRITAIN. Total Membership, 45.

HONORARY MEMBERS.—***London, Eng.***—D. Fox, W. H. White.

MEMBERS.—***Birmingham, Eng.***—H. P. Raikes. ***Carlisle, Eng.***—G. J. Bell. ***Edinburgh, Scotland.***—J. H. Cunningham. ***Farnham, Eng.***—E. H. Hurry. ***Freshford, Eng.***—E. H. Stone. ***Glasgow, Scotland.***—J. Smith. ***Hitchin, Eng.***—D. Simson. ***Ightham, Eng.***—J. R. Bell. ***London, Eng.***—R. Ballard. R. T. Bayliss, W. H. Booth, A. N. Connett, A. G. Glasgow, J. W. Grimshaw, K. P. Hawksley. R. Hawxhurst, Jr., H. C. Hoover, J. W. Jacomb-Hood, Z. E. Knapp, F. V. T. Lee, J. A. McDonald, C. F. Marsh, O. J. Marstrand, H. S. Maxim, E. W. Moir, J. P. O'Donnell, J. Orange, F. Palmer, J. E. Selander, M. E. Yeatman. ***Manchester, Eng.***—W. H. Hunter. ***Newcastle-upon-Tyne, Eng.***—J. M. Moncrieff.

ASSOCIATE MEMBERS.—***Ashford, Eng.***—P. à M. Parker. ***Glasgow, Scotland.***—A. Hunter. ***London, Eng.***—J. Abella, C. J. Armstrong, C. D. Drew. ***Pentyrch, Wales.***—G. D. B. Turner. ***Widnes, Eng.***—P. M. Pritchard.

JUNIORS.—***Birmingham, Eng.***—G. B. G. Hull. ***Glasgow, Scotland.***—R. M. Smith. ***Hull, Eng.***—E. G. Walker. ***London, Eng.***—R. Tappan.

ITALY. Total Membership, 2.

MEMBERS.—***Alassio.***—H. S. Haines. ***Rome.***—L. Luiggi.

NETHERLANDS. Total Membership, 2.

MEMBERS.—***Delft***—R. P. J. Tutein-Nolthenius.

JUNIORS.—***Utrecht.***—J. A. de Lint.

NORWAY. Total Membership, 2.

ASSOCIATE MEMBERS.—***Christiania.***—A. Gundersen, G. H. Vedeler.

RUSSIA. Total Membership, 7.

MEMBERS.—***Caucasus.***—T. S. Shmeleff. ***St. Petersburg.***—S. de Kareischa, S. P. Maximoff, V. E. Timonoff.

ASSOCIATE MEMBERS.—***Archangel.***—U. Taubenheim.

JUNIORS. ***Suwalki.***—A. I. Wolkowyski. ***Warsaw.***—A. Mischke.

SPAIN. Total Membership, 1.

MEMBERS.—***Barcelona.***—J. Tintorer y Giberga.

SWEDEN. Total Membership, 3.

ASSOCIATE MEMBERS.—***Göteborg.***—J. K. Selmer. ***Malmo.***—G. V. Dieden. ***Stockholm.***—I. Kreuger.

SWITZERLAND. Total Membership, 1.

MEMBERS.—***Zurich.***—K. E. Hilgard.

AFRICA.

Total Membership, 9.

MEMBERS.—***Buiko, German East Africa.***—A. T. Kroeber. ***Bulawayo, Rhodesia.***—C. Corner. ***Grootfontein, German Southwest Africa.***—T. Tönnesen. ***Johannesburg, Transvaal.***—J. Orr.

ASSOCIATE MEMBERS.—***Bethlehem, Orange River Colony.***—W. M. Homan. ***Britstown, Cape Colony.***—J. T. B. Gellatly. ***Germiston, Transvaal.***—A. W. Stockett. ***Johannesburg, Transvaal.***—S. F. Stokes.

JUNIORS.—***Kinshasa, Congo Belge.***—W. J. Millard.

ASIA.

CHINA. Total Membership, 24.

MEMBERS.—***Canton.***—K. Y. Kwong. ***Chinwangtao.***—R. A. McConaghy. ***Nanking.***—T. W. T. Tuckey. ***Peking.***—C. D. Jameson, T. Y. Jeme. ***Shanghai.***—E. J. Müller. ***Tientsin.***—T. H. Handbury. ***Yunnanfu.***—W. S. Dawley.

ASSOCIATE MEMBERS.—***Canton.***—C. S. Paget, H. A. Raider. ***Changsha.***—R. C. Johnson. ***Dairen.***—T. Shima. ***Foochow.***—E. F. Black. ***Hankow.***—H. E. Baker. ***Ichang.***—T. C. Yen. ***Nanking.***—T. J. Bourne. ***Shanghai.***—W. H. Dietrich, T. A. Ross. ***Tientsin.***—M. H. Peck, J. C. Vliegenthart, W. R. Wilson.

JUNIORS.—***Shanghai.***—A. K. McCampbell, T. C. Sun. ***Weihsien.***—H. E. Chandler.

INDIA. Total Membership, 7.

MEMBERS.—***Lahore.*** C. Lall. ***Madras.***—F. J. E. Spring. ***Trichur.***—G. E. Browning.

ASSOCIATE MEMBERS.—***Calcutta.***—E. Brook-Fox, R. H. Sears. ***Fort Bombay.*** G. F. F. Osborne.

JUNIORS.—***Poona City.***—S. R. Bhâgwat.

JAPAN. Total Membership, 23.

MEMBERS. ***Kobe.***—N. Shiraishi. ***Kyoto.***—U. Ogawa, S. Tanabe. ***Tokyo.***—T. Endo, I. Hiroi, C. Kadono, S. Kondo, T. Kondo, M. Otagawa, M. Sengoku, T. Tsuji, J. Yamaguchi. ***Yokohama.***—A. J. Bowie.

ASSOCIATE MEMBERS.—***Gunbaken.***—Y. Wada. ***Kumamoto.*** T. Kawaguchi. ***Osaka.***—S. Sekiba. ***Sendai.***—C. Oinouye. ***Takow.***—E. Watanabe. ***Tokyo.***—T. Chiba, K. Ichinose, H. Inagaki, M. Kabashima.

ASSOCIATES.—***Kyoto.***—K. Futami.

PHILIPPINE ISLANDS. Total Membership, 46.

MEMBERS. ***Cavite.*** R. E. Bakenhus. ***Manila.***—H. C. Delano, O. D. Filley, L. F. Goodale, C. E. Gordon, H. L. Higgins, C. W. Hubbell, O. L. Ingalls, C. H. McKinstry, W. B. Poland, C. M. Pritchett, W. H. Robinson, E. P. Shuman, C. G. Wrentmore.

ASSOCIATE MEMBERS.—***Cagayan.***—M. Cilley. ***Cebu.*** H. F. Cameron. ***Iloilo.***—B. B. Harris. ***Manila.*** J. H. Ayres, C. Bradshaw, W. C. Bunnel, A. Gideon, C. N. Kast, C. W. Keith, W. Kelly, G. K. Larrison, H. P. Linnell, M. J. McDonough, F. D. Nash, H. I. Shoemaker, W. H. Waugh.

ASSOCIATES.—***Manila.***—G. G. Stroebe, E. P. Thompson.

JUNIORS. ***Albay.***—C. G. Morrison. ***Cebu.*** J. W. Graham. ***Manila.*** L. W. Abrons, C. O. Brown, J. C. Carpenter, J. B. T. Colman, H. W. Corp, S. G. Cutler, G. W. Davis, E. L. Driggs, E. L. Lundgren, N. R. Macklem, S. W. Moore. ***Zamboanga.***—V. R. Stirling.

STRAITS SETTLEMENTS. Total Membership, 3.

MEMBERS.—***Singapore.***—S. Tomlinson.

ASSOCIATE MEMBERS.—***Singapore.***—H. M. Butterfield.

JUNIORS.—***Singapore.***—H. M. Hoisington.

AUSTRALASIA.

Total Membership, 24.

MEMBERS.—***Adelaide, Australia.***—A. B. Moncrieff. ***Brisbane, Australia.***—J. B. Henderson, E. J. T. Manchester. ***Charleston, Australia.***—A. S. Frew. ***Christchurch, New Zealand.***—C. J. R. Williams. ***Marrickville, Australia.***—R. Watkins. ***Melbourne, Australia.***—J. M. Coane, T. W. Fowler, G. Higgins, M. E. Kernot, H. C. Mais, E. Mead. ***Narbethong, Australia.***—J. T. N. Anderson. ***Newcastle, Australia.***—P. Allan. ***Sydney, Australia.***—W. H. Warren. ***Wellington, New Zealand.***—J. E. Fulton.

ASSOCIATE MEMBERS.—***Adelaide, Australia.***—H. F. Nichols. ***Chelmer, Australia.***—R. D. A. Frew. ***Essendon, Australia.***—W. M. Pullar. ***Longford, Tasmania.***—F. P. St. Hill. ***Malloy, Australia.***—A. J. R. Frew. ***Poverty Bay, New Zealand.***—W. S. Charlsworth. ***Wanganui, New Zealand.***—E. Crow.

ASSOCIATES.—***Sydney, Australia.***—H. L. Hughes.

ADDRESS UNKNOWN.

Total, 19.

MEMBERS.—W. Crawford, E. D. Graves, N. P. Hara Aiyar, A. B. Paine, J. A. Seddon.

ASSOCIATE MEMBERS.—C. C. Boyer, A. B. Dodd, T. H. Gronwall, J. G. Johnston, J. D. Lombardo, J. F. Rodenbough, E. H. Welles.

ASSOCIATES.—T. M. May.

JUNIORS.—L. P. Bremer, R. L. Ramsdell, J. H. Sawyer, A. A. Schlickeisen.

FELLOWS.—E. W. Coit, G. Merritt.

TOTAL MEMBERSHIP, 5 858.

SUMMARY OF GEOGRAPHICAL DISTRIBUTION.

NORTH AMERICA.

CANADA		111
MEXICO		65
UNITED STATES.		
Alabama	32	
Alaska	1	
Arizona	18	
Arkansas	13	
California	339	
Colorado	82	
Connecticut	84	
Delaware	18	
District of Columbia	106	
Florida	29	
Georgia	35	
Hawaii	15	
Idaho	42	
Illinois	297	
Indiana	34	
Iowa	31	
Kansas	34	
Kentucky	50	
Louisiana	42	
Maine	26	
Maryland	70	
Massachusetts	293	
Michigan	91	
Minnesota	63	
Mississippi	27	
Missouri	190	
Montana	40	
Nebraska	25	
Nevada	8	
New Hampshire	11	
New Jersey	190	
New Mexico	12	
New York	1 598	
North Carolina	24	
North Dakota	2	
Ohio	169	
Oklahoma	18	
Oregon	83	
Pennsylvania	488	
Rhode Island	49	
South Carolina	19	
South Dakota	10	
Tennessee	50	
Texas	90	
Utah	37	
Vermont	7	
Virginia	71	
Washington	127	
Carried forward	5 190	176
Brought forward	5 190	176
West Virginia	36	
Wisconsin	42	
Wyoming	14	5 282

CENTRAL AMERICA.

COSTA RICA	3	
HONDURAS	1	
NICARAGUA	1	
PANAMA	42	47

SOUTH AMERICA.

ARGENTINE REPUBLIC	12	
BOLIVIA	3	
BRAZIL	16	
CHILI	5	
COLOMBIA	4	
ECUADOR	1	
PERU	7	
URUGUAY	1	49

WEST INDIA ISLANDS.

CUBA	46	
DOMINICA	1	
JAMAICA	3	
PORTO RICO	12	
SANTO DOMINGO	5	
TRINIDAD	1	68

EUROPE.

AUSTRIA	4	
DENMARK	2	
FRANCE	7	
GERMANY	5	
GREAT BRITAIN	45	
ITALY	2	
NETHERLANDS	2	
NORWAY	2	
RUSSIA	7	
SPAIN	1	
SWEDEN	3	
SWITZERLAND	1	81

AFRICA.

Total in Africa		9

ASIA.

CHINA	24	
INDIA	7	
JAPAN	23	
PHILIPPINE ISLANDS	46	
STRAITS SETTLEMENTS	3	103

AUSTRALASIA.

Total in Australasia		24
Address Unknown		19

Total Membership, 5 858.

SUBSCRIBERS TO THE BUILDING FUND.

1881 to 1886.

The names of deceased subscribers to this fund, and of those whose address is unknown, have been omitted from this list, and the names of many living subscribers have, with their consent, also been omitted.

Boston Gas Light Company.................24 West St., Boston, Mass.

Boyd, Charles R..Wytheville, Va.

Griswold, Frank L...............Cruz del Eje, Cordoba, Argentine Republic.

Maher & Brayton..Cleveland, Ohio.

Sorzano, Julio F...............................52 Broadway, New York City.

Towle, Stevenson ....17 West 90th St., New York City.

PAST AND PRESENT OFFICERS

AND YEARS IN WHICH THEY HELD OFFICE.

The figures of the year during which office was held are, to save space, printed without those of the century. In some cases they do not show the year in which office was taken; for instance, an officer whose term extended from November, 1873, to November, 1875, appears in this table as having held office during 1874 and 1875, or 74–75.

The names of deceased members are printed in italics.

NAME.	Pres.	Vice-Pres.	Sec.	Treas.	Director.
ADAMS, ARTHUR LINCOLN	....	....	......	......	07–09
Adams, Julius Walker	74–75	68–73	......	......	53, 76
Allen, Horatio	72–73	....	......	......	......
ANDREWS, HORACE	....	....	......	......	08–10
Archbald, James	....	....	......	......	87
BATES, ONWARD	09	06–07	......	......	......
Becker, Max Joseph	89	....	......	......	......
BELKNAP, WILLIAM ETHELBERT	....	....	......	......	10–11
BENSEL, JOHN ANDERSON	10	07–08	......	......	99–01
BENZENBERG, GEORGE HENRY	07	01–02	......	......	95–97
BISSELL, HEZEKIAH	....	....	......	......	05–07
BOGART, JOHN	....	....	78-90	76-77, 91-94	73–75
BOLLER, ALFRED PANCOAST	....	11	70–71	......	72
BONTECOU, DANIEL	....	....	......	......	96–98
Bouscaren, Louis Gustave Frederic	....	03–04	......	......	81
BOWMAN, AUSTIN LORD	....	....	......	......	05–07
BRACKETT, DEXTER	....	....	......	......	08–10
BRIGGS, JOSIAH ACKERMAN	....	....	......	......	01–03
BROWNE, GEORGE HAMILTON	....	....	......	......	95–97
Brush, Charles Benjamin	....	92–93	......	......	88–91
BUCHHOLZ, CARL WALDEMAR	....	....	......	......	99–01
Buck, Leffert Lefferts	....	....	......	.....	92–94
BUCK, RICHARD SUTTON	....	....	......	......	02–04
BURR, WILLIAM HUBERT	....	....	......	......	94–96
CARTER, EDWARD CARLOS	....	....	......	......	01–03
Cartwright, Robert	....	99–00	......	......	95-97
CASEY, THOMAS L.*	....	....	......	......	82
Chanute, Octave	91	80–81	......	......	74-76, 85
Chesbrough, Ellis Sylvester	78	....	......	......	70
CHESBROUGH, I. C.*	....	....	......	......	55-67
CHRISTIE, JAMES	....	....	......	......	07–09
CHURCHILL, CHARLES SAMUEL	....	....	......	......	08–10
Clark, Jacob Merrill	....	72–73	......	......	70–71
CLARKE, ELIOT CHANNING	....	....	......	......	89
CLARKE, GEORGE CALBRAITH	....	....	......	......	11
Clarke, Thomas Curtis	96	71	......	......	79
COHEN, MENDES	92	90	......	......	88
COLLINGWOOD, FRANCIS	....	....	91–94	......	73–76
COOPER, THEODORE	....	....	......	......	84–85
Copeland, Charles W.	....	53–69	......	......	......
CORTHELL, ELMER LAWRENCE	....	89, 93–94	......	......	......
COURTENAY, WILLIAM HOWARD	....	....	......	......	11
Craighill, William Price†	94	....	......	......	92–93
CRAVEN, ALFRED	....	....	......	......	03–05
Craven, Alfred Wingate	70–71	54–67	......	......	53, 68–69, 72–73
Croes, John James Robertson	01	88	......	78–87	77
CROSBY, BENJAMIN LINCOLN	....	....	......	......	97–99
CROWELL, FOSTER	....	....	......	......	93–95
CURTIS, FAYETTE SAMUEL	....	04–05	......	......	95–97
Curtis, William Giddings	....	....	......	......	90
DAVIS, JOSEPH PHINEAS	....	84	......	......	78, 81–83

* Resigned.

† Elected President during his term of office as Director.

PAST AND PRESENT OFFICERS

Name.	Pres.	Vice-Pres.	Sec.	Treas.	Director.
Davison, George Stewart					03–05
Deyo, Solomon LeFevre		04–05			98–00
Dresser, George Warren					82
Eads, James Buchanan		82			
Ellis, John Waldo					04–06
Ellis, Theodore Grenville		74-77			79
Ely, Theodore Newel					92–93
Endicott, Mordecai Thomas	11	08–09			01–03
Fanning, John Thomas§		10–11			93–95
Fink, Albert	80	78–79			
Fisher, Edwin Augustus					05-07
FitzGerald, Desmond	99	95–96			92–94
Flad, Henry	86	83			
Foote, Arthur DeWint					10–11
Ford, James K.*					68–69
Forney, Matthias N.*					77
Forsyth, Robert					87
Francis, James Bicheno	81	70, 79–80			
Frazier, James Lewis					02–04
Freeman, John Ripley		02–03			96–98
Fteley, Alphonse	98	89–91			88
Fuertes, Estevan Antonio					92
Gardiner, Edward		53	54	54	
Gardner, William Montgomery					09–11
Gibbs, George					06–08
Gillmore, Quincy Adams					76
Gorsuch, Robert Bennett			53	53	
Gottlieb, Abraham					92–93
Gowen, Charles Sewall					04–06
Graff, Frederic	85				84
Gray, Samuel Merrill		92			
Green, Bernard Richardson		06–07			94–96
Greene, George Sears	76-77				68–69, 71, 73, 75, 77–79
Greene, George Sears, Jr.		85		88–90	82–84, 86
Gzowski, Sir Casimir Stanislaus					94
Haines, Henry Stevens		01-02			97–99
Hamilton, William Gaston					83–87
Harrison, Charles Lewis					08–10
Harrod, Benjamin Morgan	97	95–96			92–94
Hazen, Allen					07-09
Hering, Rudolph		00–01			91, 97–99
Hermany, Charles	04	91			80
Herschel, Clemens					91
Hill, Albert Banks					92
Hodgdon, Frank Wellington					07-09
Holley, Alexander Lyman		77			76
Holman, Minard Lafever		05-06			
Horton, Horace E.					07-09
Hunt, Charles Warren			95-11		
Hutton, William Rich		96-97			84-86
Jackson, William					02-04
Johnson, James M.					06–08
Johnson, Lorenzo Medici					97–99
Johnson, Thomas H.					00–02
Just, George Alexander					96–98
Katté, Walter					85, 89
Keefer, Thomas Coltrin	88	86–87			82
Kennedy, John					98–00
Kennedy, William Harlin†					02–03
Kiersted, Wynkoop					06–08
Kimball, George Albert					10–11
Kirkwood, James Pugh‡	68				53–67
Kittredge, George Watson					08–10
Knap, Joseph Moss				00–11	94–96
Kuichling, Emil		05–06			01–03
Landreth, Olin Henry					93–95
Landreth, William Barker					05–07
Laurie, James	53-67				
Leverich, Gabriel			72-77		

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* Resigned.

† Elected Director Dec. 3d, 1901, to fill the vacancy caused by the death of George A. Quinlan.

‡ Mr. Kirkwood resigned the Presidency August 5th, 1868, and Mr. McAlpine was elected for the unexpired period.

§ Mr. Fanning died February 6th, 1911, during his term as Vice-President.

PAST AND PRESENT OFFICERS

Name.	Pres.	Vice-Pres.	Sec.	Treas.	Director.
Lewis, Eugene Castner					03–05
Lewis, Nelson Peter					04–06
Loomis, Horace					10–11
Loweth, Charles Frederick					10–11
Ludlow, William					90
Macdonald, Charles	08	93–94			71, 74–75
MacLeod, John		92			
McAlpine, William Jarvis†	68–69				54–67, 70
McDonald, Hunter		10–11			03–05
McMath, Robert Emmet					89
McNulty, George Washington					92–93
McVean, John Jay					98–00
Manley, Henry					98–00
Martin, Charles Cyril		94–95			
Marx, Charles David					04–06
Mead, Elwood					03–05
Mendell, George Henry		97–98			
Merrill, William Emery					83
Metcalf, William	93				83–84
Meyer, Thomas C.‡			69		
Modjeski, Ralph					04–06
Moore, Robert	02	88, 99–00			92–93
Mordecai, Augustus					95–97
Morell, W. H.					53
Morison, George Shattuck	95				
Morris, Henry Gurney					86
Morse, Henry Grant					97–99
Morse, James Otis			55–69	55–75	54–67, 77
Myers, Charles Hayward					92
Myers, Edmund Trowbridge Dana					92
Nichols, Othniel Foster					92–93
Noble, Alfred§	03	00–01			95
North, Edward P		98–99			91
Ockerson, John Augustus		07–08			
O'Rourke, John Francis					00–02
Osborn, Frank Chittenden					01–03
Osgood, Joseph Otis					03–05
Owen, James					97–99
Paine, Charles	83				
Paine, William H.		82–84			77–81
Parsons, William Barclay					96–98
Pegram, George Herndon		09–10			02–04
Peterson, Peter Alexander		96–97			92–93
Pierson, George Spencer					05–07
Pope, Willard Smith					93–95
Pratt, J. W.					54
Prosser, Thomas					70
Prout, Henry Goslee					93–95
Quinlan, George Austin					00–01
Ramsey, Joseph, Jr.					00–02
Read, Robert Leland					92–93
Richardson, Henry Brown					00–02
Ricketts, Palmer Chamberlaine					99–01
Ridgway, Robert					11
Roberts, Percival, Jr.					10–11
Roberts, William Milnor	79	74–76, 78			77
Rowland, Thomas Fitch		86–87			71–73
Rundlett, Leonard W					11
Schneider, Charles Conrad	05	02–03			87, 98–00
Schuyler, James Dix		03–04			92, 99–01
Seaman, Henry Bowman					00–02
See, Horace*					96–98
Sherrerd, Morris Robeson					05–07
Shinn, William Powell	90				89
Sidell, W. H.					53
Smith, Charles Shaler					78
Smith, Charles Vandervoort					78–81

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* Resigned.

† Mr. Kirkwood resigned the Presidency August 5th, 1868, and Mr. McAlpine was elected for the unexpired term.

‡ November 3d, 1869, to January 5th, 1870.

§ Elected Director Nov. 5th, 1895, to fill the vacancy caused by the death of Willard S. Pope.

Name.	Pres.	Vice-Pres.	Sec.	Treas.	Director.
Smith, J. Waldo					06–08
Smith, T. Guilford					94–96
Snow, Jonathan Parker					11
Sooysmith, Charles					95–97
Stanton, Robert Brewster					94–96
Stearns, Frederic Pike	06	98–99			93–95
Storey, William B., Jr					06–08
Stott, Henry Gordon					11
Strobel, Charles Louis†		11			86, 94
Stuart, Francis Lee					09–11
Sumner, Horace Augustus					09–11
Swain, George Fillmore		08–09			01–03
Swensson, Emil		09–10			06–08
Symons, Thomas William*					96–98
Talbot, Arthur Newell					09–11
Talcott, William Hubbard					54–68
Thompson, Samuel Clarence					09–11
Thomson, John				95–99	92–94
Tillson, George William					07–09
Towle, Stevenson					87–88
Turner, Edmund Kimball					99–01
Van Buren, Robert					90
Van Hoesen, Edmund French					02–04
Van Horne, John Garret					92
Van Winkle, Edgar Beach					80
Vaughan, Frederic Willis					85
Voorhees, Theodore					90
Wallace, John Findley	00	97–98			
Ward, John Frothingham*					68–72
Warren, Gouverneur K.*					80
Webster, George Smedley					04–06
Welch, Ashbel‡	82	81			
Whinery, Samuel		92–93			91, 99–01
Whitcomb, Henry Donald					94–96
White, William Howard					86
Whitman, Thomas Jefferson		85			
Whittemore, Don Juan	84				81
Wilgus, William John					02–04
Wilkins, William Glyde					09–11
Williams, Gardner Stewart					08–10
Wilson, Joseph Miller		94–95			88
Wisner, George Y.					98–00
Wood, De Volson*					74
Worthen, William Ezra	87				72

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* Resigned.

† Elected Director to fill the vacancy caused by the death of Abraham Gottlieb, Feb. 9th, 1894.

‡ Mr. Welch died September 25th, 1882, during his term of office as President.

DECEASED MEMBERS

H. M., Honorary Member. M., Member. A., Associate. A. M., Associate Member. J., Junior. F., Fellow.

Name	Date of Election	Date of Death	Memoirs*
Abbott, Arthur Vaughan	J. 1881 M. Dec. 4, 1901	Dec. 1, 1906	....
Abbott, Job	M. April 1, 1891	Aug. 18, 1896	*XXXVI, 538*
Abert, John James	H. M. Mar. 2, 1853	Jan. 27, 1862	XIX, 88
Abert, Sylvanus Thayer	M. Sept. 21, 1870	Aug. 11, 1903	*LIX, 521*
Ackenheil, Charles	M. Feb. 2, 1887	June 20, 1890	XVII, 137
Adams, Julius Walker	M. 1852 H. M. Oct. 26, 1888	Dec. 13, 1899	....
Adgate, George	M. April 1, 1896	Jan. 23, 1909	*LXV, 514*
Ainslie, George	F. May 28, 1872	Sept. 6, 1878	XV, 41
Ainslie, James W	F. May 28, 1872	Sept. 13, 1902	....
Ainsworth, Danforth Hurlbut	M. Mar. 3, 1886	April 24, 1904	*LIV, 522*
Aldrich, James Colwell	M. May 7, 1873	April 3, 1900	*XLV, 617*
Allaire, William Miller	J. Mar. 2, 1881	Dec. 14, 1884	XIX, 67
Allen, Horatio	M. 1867 H. M. Mar. 4, 1874	Dec. 31, 1889	XVI, 180
Allen, Theodore	M. Nov. 16, 1870	Sept. 18, 1890	XVII, 240
Allen, William Albert	M. May 6, 1891	Mar. 21, 1896	*XXXVI, 539*
Allis, Edward Phelps	F. Aug. 4, 1883	April 1, 1889	XV, 168
Ambrose, William Creelman	M. April 4, 1888	Jan. 3, 1909	....
Anderson, Adna	M. Sept. 2, 1874	May 15, 1889	XV, 166
Ansley, George Doane	M. Sept. 4, 1878	Sept. 22, 1883	XV, 109
Archbald, James	M. May 15, 1872	Oct. 5, 1910	....
Armington, James Hervey	M. July 6, 1870	Oct. 14, 1906	....
Arthur, William Young	M. 1867 F. Sept. 20, 1870	Feb. 15, 1876	....
Aspinwall, William Howard	F. July 9, 1870	Jan. 18, 1875	*XXXVI, 598*
Asserson, Peter Christian	M. July 5, 1882	Dec. 6, 1906	....
Atwood, William Henry	M. May 4, 1881	Sept. 4, 1890	XVII, 205
Avery, John	M. Dec. 4, 1867	Jan. 30, 1884	XI, 117
Bache, Alexander Dallas	H. M. Mar. 2, 1853	Feb. 17, 1867	*XXXVI, 522*
Bacon, John Watson	M. July 12, 1877	Feb. 27, 1907	....
Baier, Julius	J. 1887 A. M. 1892 M. Feb. 6, 1901	May 8, 1905	....
Bailey, George Irving	M. Oct. 1, 1890	Mar. 28, 1908	*LXI, 556*
Bailey, Thomas Norton	M. Nov. 7, 1883	April 20, 1886	XVI, 186
Baker, *Sir* Benjamin	H. M. May 5, 1897	May 19, 1907	....
Baker, William Latimer	J. 1875 M. Nov. 6, 1878	May 28, 1888	XV, 111
Baldwin, Henry Furlong	A. M. 1892 M. Feb. 6, 1895	June 17, 1909	*LXVII, 621*
Ball, Ernest Stearns	J. May 2, 1905	Nov. 22, 1909	*LXVI, 510*
Bannister, Charles Kimball	M. May 3, 1893	Jan. 10, 1901	....
Barber, Amzi Lorenzo	F. Mar. 19, 1886	April 18, 1909	....
Barbour, William Sullivan	M. April 17, 1872	Feb. 24, 1889	XV, 142
Barnard, John Fiske	M. Sept. 1, 1880	Feb. 6, 1910	*LXVIII, 469*
Barnard, John Gross	M. 1869 H. M. April 7, 1873	May 14, 1882	XIII, 134
Barnes, David Leonard	M. July 2, 1890	Dec. 15, 1896	*XLI, 618*
Barnes, James	M. Mar. 13, 1853	Feb. 12, 1869	*XXXVI, 540*
Barnes, Oliver Weldon	M. July 6, 1881	Nov. 14, 1908	....
Barnsley, George Thomas	J. 1892 A. M. 1894 M. Feb. 6, 1906	Oct. 23, 1909	....
Barr, Jacob Neff	M. Nov. 7, 1888	May 15, 1904	....
Barriger, John Walker, Jr.	J. 1898 A. M. April 2, 1902	Dec. 19, 1902	*LVI, 477*
Bartlett, Winthrop	M. Jan. 2, 1889	Jan. 16, 1899	....
Bassell, Burr	M. Nov. 4, 1903	Feb. 25, 1905	....
Batterson, James Goodwin	F. June 7, 1876	Sept. 18, 1901	....
Baumann, Edward	A. June 2, 1880	Jan. 26, 1889	XV, 114
Bayley, George William Read	M. July 10, 1872	Dec. 14, 1876	IV, 58
Beardsley, Frank Chester	M. Nov. 7, 1894	July 1, 1895	XXI, 182
Becker, Max Joseph	M. Aug. 7, 1872	Aug. 23, 1896	*XXXVII, 555*

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* The italic references in this list are to the volume and page of *Transactions*, in which the Memoirs prepared after January 1st, 1896, were published; the other figures refer to the volume and page of *Proceedings*, where the Memoirs prepared earlier than that date will be found.

Name		Date of Election	Date of Death	Memoirs*
Beckler, Elbridge Harlow	M.	April 6, 1892	Aug. 26, 1908	....
Behrens, William Frederic	J.	1889 A. M. June 7, 1893	Feb. 6, 1894	XX, 87
Belknap, Morris Sheppard	M.	Aug. 7, 1872	July 19, 1890	XVI, 167
Bell, Henry Purdon	M.	June 4, 1884	†	....
Bell, James E	M.	Mar. 5, 1879	June 9, 1879	V, 98
Bentley, Henry Adamson	M.	Mar. 2, 1881	May 13, 1889	....
Benyaurd, William H. H	M.	Nov. 3, 1875	Feb. 7, 1900	....
Beresford, Frank	J.	Sept. 7, 1887	Dec. 12, 1887	*XXXVI, 594*
Berg, Walter Gilman	M.	Feb. 5, 1896	May 12, 1908	....
Bergengren, Fritz Carl Anders Georg	A. M.	Dec. 2, 1896	Aug. 8, 1904	....
Berrian, Richard Milford	M.	May 4, 1887	Dec. 23, 1907	*LXII, 550*
Biddle, William Foster	M.	June 4, 1884	Aug. 10, 1910	....
Birch-Nord, Carl William	J.	1906 A. M. Nov. 4, 1908	Sept. 15, 1909	*LXVI, 509*
Birks, Arthur Henry	J.	1904 A. M. Nov. 7, 1906	Aug. 29, 1907	....
Bishop, George H	M.	Aug. 7, 1872	Aug. 20, 1909	....
Bishop, Thomas Sparks	M.	Sept. 2, 1885	Nov. 13, 1898	*XLI, 621*
Blackwell, Charles	M.	Sept. 7, 1881	Dec. 29, 1906	*LIX, 531*
Blaisdell, Anthony Houghtaling	M.	Mar. 3, 1880	Sept. 9, 1905	*LVI, 464*
Blake, Edward Josiah	M.	April 3, 1889	May 29, 1902	....
Blickensderfer, Jacob	M.	June 1, 1881	Feb. 26, 1899	....
Bliss, Henry Isaac	M.	Sept. 5, 1883	July 10, 1896	*XXXVI, 541*
Blunden, Henry D	J.	1876 M. Feb. 4, 1880	Jan. 7, 1889	*XXXVI, 542*
Bodfish, Sumner Homer	M.	Oct. 2, 1889	May 17, 1894	XX, 96
Boeke, August William	M.	Sept. 3, 1890	Oct. 24, 1894	XX, 204
Bogart, James Peter	J.	1882 M. July 3, 1895	Dec. 24, 1903	*LII, 545*
Bond, Frederick Winn	M.	Dec. 7, 1898	July 12, 1903	*LI, 452*
Booker, Bernard Frank	J.	1885 M. June 2, 1891	July 21, 1894	XX, 183
Both, Carl Christian Adolph	M.	Sept 2, 1891	Jan. 12, 1906	....
Bouscaren, Louis Gustave Frederic	M.	April 7, 1875	Nov. 6, 1904	*LIX, 533*
Bouton, Nathaniel S	F.	Dec. 30, 1872	April 3, 1908	....
Bowman, Joseph Hockman	A. M.	Dec. 2, 1903	†	....
Boyle, Olin McClintock, Jr	J.	Mar. 5, 1907	Aug. 19, 1908	*LXIV, 591*
Bradbury, Henry Robert	A.	July 6, 1881	July 3, 1901	....
Breckinridge, Cabell	M.	June 1, 1881	Nov. 13, 1907	*LXV, 529*
Breen, Howard	M.	April 4, 1888	Feb. 14, 1909	....
Bridgford, John	F.	Jan. 14, 1871	Mar. 8, 1898	....
Briggs, Albert Dwight	F.	May 17, 1870	Feb. 20, 1881	XV, 132
Briggs, Robert	M.	Oct. 19, 1870	July 24, 1882	*XXXVI, 542*
Brinckerhoff, Henry Waller	M.	Nov. 7, 1883	Sept. 7, 1909	*LXVI, 495*
Brodhead, Calvin Easton	M.	Feb. 21, 1872	April 29, 1907	*LX, 579*
Brough, Redmond John	M.	Sept. 1, 1880	July 21, 1883	XII, 40
Brown, Alba Fisk	M.	Sept. 7, 1887	April 22, 1906	....
Brown, Charles Irwin	M.	Jan. 7, 1891	Mar. 23, 1899	....
Brown, John Milton	M.	April 1, 1874	June 16, 1874	I, 170
Brown, Linus Weed	M.	June 7, 1899	Mar. 7, 1910	*LXX, 470*
Browne, William Robert	M.	June 1, 1898	Sept. 3, 1908	....
Bruner, Daniel Pastorius	J.	1876 M. May 7, 1879	Aug. 29, 1901	....
Brush, Charles Benjamin	A.	1871 M. Sept. 5, 1877	June 3, 1897	....
Brynn, Per	A. M.	Feb. 4, 1903	Feb. 10, 1906	*LVII, 528*
Buck, Leffert Lefferts	M.	Feb. 3, 1875	July 17, 1909	....
Buckhout, Isaac Craig	M.	July 15, 1872	Sept. 27, 1874	I, 171
Burden, Henry	H. M.	Mar. 2, 1853	Jan. 19, 1871	....
Burden, James Abercrombie	M.	July 2, 1879	Sept. 23, 1906	....
Burns, Justin	A. M.	April 6, 1898	Nov. 14, 1905	*LVII, 529*
Burns, Robert Bruce	M.	Sept. 5, 1900	June 21, 1906	....
Burr, James Dewey	M.	April 5, 1876	May 5, 1886	XII, 107
Burrowes, Francis Smith	M.	June 6, 1888	Feb. 15, 1909	....
Burton, Standish Barry	M.	June 1, 1898	Aug. 13, 1904	*LV, 444*
Butts, Elijah Polhill	J.	Nov. 3, 1886	Jan. 11, 1892	XVIII, 129
Buxton, Clifford	M.	May 6, 1885	Jan. 12, 1910	*LXVII, 623*
Camp, Jonathan, Jr	M.	Dec. 31, 1873	April 16, 1874	I, 186
Campbell, Albert Johnstone	A. M.	May 2, 1894	Mar. 23, 1907	*LIX, 563*
Campbell, Allan	M.	1868 H. M. Mar. 1, 1892	Mar. 18, 1894	XX, 179
Campbell, Charles Edward Henry	M.	Oct. 3, 1883	Dec. 6, 1902	*LII, 547*
Card, Joseph P	A.	Sept. 5, 1883	Oct. 22, 1894	XXI, 68
Card, William Warren	M.	Sept. 5, 1883	April 4, 1903	....
Carothers, Daniel Dawson	M.	April 4, 1894	Jan. 2, 1909	*LXIV, 581*
Carpenter, Clarence Allan	M.	May 2, 1888	Nov. 9, 1899	....
Carrel, Frederick Janvrin	M.	Mar. 5, 1884	May 2, 1894	*XXXVII, 559*
Cartwright, Henry	M.	Sept. 6, 1876	June 30, 1881	VII, 124
Cartwright, Robert	M.	July 10, 1872	June 4, 1905	....
Cary, Edgar Sheldon	M.	Nov. 1, 1882	Jan. 5, 1883	*XLVI, 555*
Cass, George Washington, Jr	F.	Mar. 30, 1871	Mar. 21, 1888	*XXXVI, 599*
Catt, George William	M.	Sept. 7, 1892	Oct. 8, 1905	....

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† Date of death unknown.

DECEASED MEMBERS C-D

Name	Date of Election	Date of Death	Memoirs*
Chanute, Octave	M. 1868 F. July 11, 1872	Nov. 23, 1910	....
Chase, Samuel Stewart	M. 1868 F. Mar. 12, 1870	May 29, 1873	I, 40
Chase, William Beverly	M. Sept. 6, 1899	Oct. 27, 1908	*LXIII, 429*
Cheney, John Eugene	M. May 7, 1884	Sept. 25, 1906	*LIX, 537*
Cheney, Nathaniel	F. June 21, 1870	June 29, 1901	....
Chesbrough, Ellis Sylvester	M. June 17, 1868	Aug. 18, 1886	XV, 160
Church, George Earl	M. Nov. 2, 1887	Jan. 5, 1910	....
Cisneros, Francisco Javier	M. May 15, 1872	July 7, 1898	*XLI, 622*
Clapp, Lorenzo Russell	M. Feb. 1, 1888	Aug. 13, 1902	*XLIX, 341*
Clark, Ira Edgar	J. Feb. 6, 1878	May 23, 1882	VIII, 92
Clark, Jacob Merrill	M. Jan. 29, 1868	Dec. 21, 1894	XX, 203
Clark, John Howard	M. Nov. 4, 1903	Oct. 13, 1907	....
Clarke, Henry Wadsworth	M. Mar. 15, 1871	Feb. 23, 1892	XVIII, 93
Clarke, Thomas Curtis	M. 1868 F. May 20, 1872	June 15, 1901	*L, 495*
Cleemann, Thomas Mutter	M. Oct. 1, 1879	Nov. 16, 1893	XX, 69
Clemens, Ernest Victor	M. Mar. 1, 1893	Sept. 3, 1893	XX, 161
Clement, Victor M	F. Jan. 8, 1890	April 28, 1903	....
Cleverdon, Henry Lawrence	A. M. Mar. 1, 1899	Aug. 27, 1902	*L, 507*
Cobb, Robert Linah	M. Jan. 2, 1890	June 2, 1895	*XXXVI, 545*
Cochran, A. P	F. June 19, 1872	April 26, 1886	....
Coffin, Freeman Clarke	M. Feb. 6, 1895	Nov. 11, 1906	*LVIII, 532*
Colburn, Warren	M. Mar. 18, 1868	Sept. 15, 1879	VI, 4
Colburn, Zerah	M. Jan. 5, 1855	April 26, 1870	*XXXVI, 546*
Colby, Charles Lewis	F. July 31, 1883	Feb. 26, 1896	....
Coleman, Thomas Cooper	F. May 28, 1872	Dec. 17, 1901	....
Colman, Isaac D	M. Feb. 27, 1869	April 7, 1875	I, 331
Comfort, Silas Gildersleeve	A. Mar. 31, 1891	July 13, 1910	....
Connor, Addison	M. Jan. 5, 1887	Jan. 4, 1891	*XXXVI, 551*
Conro, Albert	F. June 13, 1883	Jan. 10, 1901	....
Constable, Casimir	M. June 17. 1868	Feb. 6, 1905	....
Cooke, Robert Latimer	M. April 17, 1872	Aug. 11, 1877	IV, 66
Cooper, Edward	F. Dec. 10, 1885	Feb. 25, 1905	....
Coppée, Henry St. Leger	M. Oct. 5, 1887	May 8, 1901	....
Correa, Edward Arnold	M. Mar. 7, 1900	June 24, 1900	*XLV, 621*
Coryell, Martin	M. Dec. 4, 1867	Nov. 30, 1886	XV, 133
Courtwright, Milton	F. June 11, 1870	April 25, 1883	....
Covode, James Henry	M. April 2, 1890	Sept. 9, 1909	....
Cox, Abraham Beekman	M. April 1, 1874	Feb. ‡ 1906	....
Coxe, Eckley Brinton	M. Feb. 7, 1877	May 13, 1895	*XXXVI, 552*
Crabb, Thomas	J. April 4, 1899	Dec. 21, 1901	....
Craighill, William Price	M. 1885 H. M. Mar. 23, 1896	Jan. 18, 1909	*LXV, 517*
Craven, Alfred Wingate	M. Nov. 5, 1852	Mar. 27, 1879	VI, 24
Craven, Henry Smith	M. Dec. 3, 1884	Dec. 7, 1889	XVI, 217
Croes, John James Robertson	M. Dec. 4. 1867	Mar. 17, 1906	*LVIII, 524*
Crosby, Wilson	M. Sept. 15, 1869	Dec. 18, 1904	*LXVII, 625*
Cunningham, John Miller	A. M. Oct. 7, 1903	Aug. 8, 1904	*LIV, 537*
Cunningham, Paul Davis	A. M. Mar. 1, 1899	July 13, 1901	*LII, 556*
Curtis, Wendell Rhodes	J. 1875 M. June 4, 1884	Mar. 7, 1893	XX, 86
Curtis, William Giddings	M. May 3, 1882	June 15, 1900	*XLV, 624*
Cushing, Oliver Edwards	M. July 10, 1872	Jan. 17, 1890	XVI, 166
Cushing, Robert Delano	A. M. Sept. 6, 1899	Aug. 23, 1903	....
Cushing, Samuel Barrett	M. Sept. 2, 1869	July 17, 1873	I, 43
Cushing, Samuel Barrett	M. June 1, 1887	Dec. 2, 1888	*XLIX, 343*
Cutshaw, Wilfred Emory	M. Mar. 4, 1891	Dec. 19, 1907	....
Dagron, James Gustavus	M. Oct. 6, 1886	May 25, 1895	....
Davidson, Matthias Oliver	M. April 6, 1853	Sept. 1, 1872	XIX, 56
Davis, Charles	M. Sept. 15, 1869	Feb. 20, 1907	....
Davis, Frank Leslie	M. Sept. 6, 1905	June 9, 1909	....
Davis, Frank Paul	M. Feb. 1, 1888	May 3, 1900	....
Davis, John Woodbridge	A. June 3, 1885	Nov. 7, 1902	*XLIX, 370*
Dawley, Edwin Peleg	M. April 1, 1885	Oct. 7, 1910	....
Deans, Charles Herbert	J. 1890 A. M. May 6, 1896	Mar. 7, 1909	*LXVIII, 482*
Dearborn, William Lee	M. Jan. 29, 1868	Mar. 15, 1875	I, 330
DeCourcy, Bolton Waller	M. Nov. 6, 1889	April 1, 1900	....
DeForest, George Thompson	A. M. Dec. 4, 1895	July 25, 1901	....
de Funiak, Frederick	M. May 7, 1873	Mar. 29, 1905	*LIV, 524*
DeGaray, Francisco	F. Aug. 31, 1883	Sept. 2, 1896	....
DeHaas, Adolph	J. Oct. 3, 1905	Dec. 28, 1907	....
Del Monte, Emilio	M. Dec. 4, 1895	Mar. 20, 1902	....
Derbishire, James Stewart	M. April 2, 1884	Jan. 2, 1887	XIII, 66
Dexter, George M	M. Dec. 3, 1852	Nov. 26, 1872	I, 40
Dickinson, George Codwise	M. Feb. 5. 1890	Jan. 24, 1892	XVIII, 71
Dickinson, Pomeroy P	M. Jan. 17, 1872	Oct. 4, 1895	*XLIII, 611*
Dillon, Sidney	F. Mar. 26, 1870	June 9, 1892	*XXXVI, 603*
Dimmick, John Bagley	M. July 10, 1907	June ‡, 1909	....

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‡ Exact date of death unknown.

Name	Date of Election	Date of Death	Memoirs*
D'Invilliers, Camille Stanislaus	M. Jan. 4, 1888	Jan. 2, 1910	....
Dirks, Justus	H. M. June 2, 1880	Dec. 26, 1886	XIII, 45
Diven, Alexander Samuel	F. June 16, 1870	June 11, 1896	*XXXVII, 571*
Doane, Thomas	M. June 7, 1882	Oct. 22, 1897	*XXXIX, 690*
Doran, Frank C	M. Sept. 5, 1883	Oct. 15, 1898	....
Dorsey, Edward Bates	M. June 4, 1879	†	....
Downes, Stancliff Bazen	J. April 7, 1886	April 21, 1895	XXI, 105
Dresser, George Warren	M. July 5, 1876	May 27, 1883	XIX, 110
Duane, James	M. Mar. 2, 1892	Jan. 12, 1899	....
Duane, James Chatham	H. M. Nov. 20, 1886	Nov. 8, 1897	*XXXIX, 686*
DuBarry, Edmund Louis	A. Jan. 6, 1875	Dec. 4, 1908	....
Du Barry, Joseph Napoleon	M. Jan. 6, 1875	Dec. 17, 1892	XIX, 108
Dudley, Charles Benjamin	M. Mar. 2, 1892	Dec. 21, 1909	....
Dudley, Charles Tarbell	J. 1904 A. M. Oct. 3, 1906	Sept. 30, 1908	*LXIV, 588*
Dun, James	M. June 7, 1876	Feb. 23, 1908	*LXI, 560*
Dunham, Charles Frederick	M. April 2, 1902	June 13, 1903	....
Durant, Thomas C	F. Nov. 18, 1870	Oct. 5, 1885	*XXXVI, 602*
Dusenberry, Walter Lorton	J. Nov. 5, 1890	May 13, 1909	*LXV, 533*
Eads, James Buchanan	M. 1868 F. Mar. 30, 1870	Mar. 8, 1887	XIII, 46
Earley, John Edwin	M. April 5, 1876	Dec. 20, 1907	*LXI, 562*
Eaton, Horace LaFayette	M. Feb. 1, 1893	Nov. 23, 1895	*XXXVI, 554*
Eayrs, Norman Wilder	M. June 3, 1885	May 13, 1900	....
Edge, George Washington	M. Mar. 4, 1874	Jan. 1, 1880	VI, 18
Edwards, Nathaniel Marsh	M. June 3, 1874	†	....
Eldridge, Archibald Ronaldson	M. Oct. 2, 1901	Jan. 17, 1907	....
Elliott, George Harford	M. April 4, 1883	Oct. 7, 1886	XV, 110
Ellis, Nathaniel Webster	M. Feb. 2, 1881	Jan. 16, 1889	XV, 112
Ellis, Theodore Grenville	M. 1869 F. Nov. 21, 1872	Jan. 9, 1883	*XXXVII, 557*
Ellsworth, Alfred Burnham	J. May 1, 1889	Jan. 10, 1893	XIX, 48
Ely, George Hervey	A. May 31, 1892	Jan. 24, 1894	....
Emack, Charles S	M. July 6, 1870	July 26, 1877	IV, 65
Emerson, George Dana	M. Sept. 18, 1872	Sept. 26, 1900	....
Emery, Charles Edward	M. May 6, 1874	June 1, 1898	*XLII, 558*
Emigh, John Hall	M. April 3, 1901	Jan. 6, 1910	*LXVII, 628*
Emmet, Thomas Addis	M. Nov. 5, 1852	Jan. 12, 1880	VI, 2
Emonts, William Alexis George	J. Sept. 6, 1876	Nov. 5, 1887	*XXXVI, 594*
Engle, Robert L	M. Sept. 7, 1881	Oct. 17, 1909	*LXVIII, 480*
Enos, George Wallace	J. Mar. 6, 1900	Nov. 2, 1905	....
Ensign, Elisha Williams	F. May 18, 1870	Oct. 1, 1877	....
Erdmann, Earl Edwin	J. July 1, 1909	Mar. 29, 1910	....
Ericsson, John	H. M. Oct. 2, 1879	Mar. 8, 1889	....
Evans, Anthony Walton White	M. 1867 F. Mar. 15, 1870	Nov. 28, 1886	XIII, 30
Evans, George Edwin	M. May 2, 1888	April 14, 1908	....
Evans, Louis Provost	M. Sept. 3, 1884	Aug. 19, 1896	....
Evans, Myron Edward	J. 1895 A. M. Feb. 7, 1900	Feb. 16, 1907	....
Falconnet, Eugene F	M. June 3, 1874	Oct. 14, 1887	XV, 135
Fales, Frank Lewis	A. M. April 6, 1904	Oct. 5, 1905	....
Fanning, John Thomas	M. Aug. 7, 1872	Feb. 6, 1911	....
Fargo, William G	F. May 6, 1870	Aug. 4, 1881	....
Farnam, Henry	F. Nov. 14, 1872	Oct. 4, 1883	*XXXVI, 605*
Farnham, Irving Tupper	M. May 1, 1907	Sept. 19, 1908	....
Farquhar, Francis Ulric	M. July 10, 1872	July 3, 1883	XV, 165
Fava, Francis Renatus, Jr	M. Nov. 5, 1890	Mar. 27, 1896	....
Feind, Anthony Erneste Bernhard	M. Jan. 2, 1890	Aug. 21, 1894	XX,182
Felton, Samuel Morse	F. Mar. 23, 1870	Jan. 24, 1889	XIX, 92
Field, Burr Kellogg	M. Oct. 1, 1884	Jan. 13, 1898	*XL, 568*
Filley, Hiel Hamilton	M. Jan. 3, 1883	May 6, 1907	....
Fink, Albert	M. 1870 F. Sept. 3, 1872	April 3, 1897	*XLI, 626*
Fisher, Charles Henry	M. June 7, 1869	Jan. 18, 1888	XIX, 66
Fisher, Clark	M. Oct. 19, 1870	Dec. 31, 1903	....
Fisher, Elstner	J. 1889 A. M. 1897 M. Mar. 5, 1902	Oct. 12, 1909	*LXVI, 497*
Flad, Henry	M. Feb. 15, 1871	June 20, 1898	*XLII, 561*
Flint, Edward Austin	M. May 18, 1870	Jan. 23, 1886	XII, 114
Flynn, Benjamin Harrison	J. Oct. 2, 1900	Mar. 1, 1903	....
Flynn, Patrick John	M. Feb. 4, 1891	June 1, 1893	XX, 68
Fogg, Charles E	M. Oct. 16 1872	April 26, 1891	XVII, 230
Ford, Arthur Livermore	A. Nov. 6, 1872	May 30, 1880	VI, 75
Forshey, Caleb Goldsmith	M. Aug. 7, 1872	July 25, 1881	*XXXVII, 560*
Fowler, Charles Edward	M. May 3, 1876	Jan. 28, 1883	XV, 164
Francis, James	M. Jan. 4, 1893	Dec. 1, 1898	*XLV, 627*
Francis, James Bicheno	M. 1852 F. 1870 H. M. April 5, 1892	Sept. 18, 1892	XIX, 74

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† Date of death unknown.

DECEASED MEMBERS F-H

Name	Date of Election	Date of Death	Memoirs*
Frank, George William	M. Feb. 1, 1899	Jan. 19, 1905	
Franklin, William Buel	M. April 1, 1874	Mar. 8, 1903	
Freeman, Ernest Grey	A. M. 1893 M. Oct. 5, 1898	Mar. 6, 1900	
Freeman, Frank Leslie	A. Nov. 5, 1895	Mar. 3, 1907	
French, Edmund	M. Nov. 26, 1852	July 7, 1860	*XXXVII, 561*
French, Frederick Reginald	M. Sept. 7, 1904	Nov. 20, 1904	*LIV, 526*
French, George Harrison	A. M. Dec. 5, 1906	July 9, 1909	
Frizell, Joseph Palmer	M. Jan. 3, 1883	May 4, 1910	
Frost, Benjamin Dix	M. Feb. 21, 1872	July 19, 1880	XIII, 139
Fry, Leslie Monroe	J. 1905 A. M. April 3, 1907	Nov. 10, 1908	
Fteley, Alphonse	M. Jan. 5, 1876	June 11, 1903	*LIV, 509*
Fuertes, Estevan Antonio	M. Feb. 17, 1869	Jan. 16, 1903	
Fujino, Shukichi	J. Feb. 3, 1903	†	
Gardiner, Edward	M. Nov. 5, 1852	†	
Gardner, George Clinton	M. Nov. 3, 1875	Aug. 12, 1904	
Gardner, Henry A.	M. Dec. 13, 1852	July 26, 1875	I, 335
Garfias, Ignacio	M. Oct. 5, 1892	Jan. 16, 1898	
Gatchell, George Samuel	M. May 7, 1884	June 22, 1909	
Gelette, William Durfree	M. April 1, 1885	April 27, 1902	*L, 500*
Giblin, Arthur Leon	J. Jan. 31, 1893	July 17, 1894	XX, 171
Gibson, William, Jr	A. Sept. 5, 1888	April 19, 1905	
Gillespie, Joshua Lathrop	J. 1875 M. April 2, 1884	Aug. 22, 1890	XVI, 224
Gillham, Robert	M. June 2, 1886	May 19, 1899	*XLIII, 613*
Gilliss, John Roberts	M. 1869 F. Mar. 15, 1870	July 15, 1870	*XXXVI, 555*
Gillmore, Quincy Adams	M. Dec. 2, 1868	April 7, 1888	XX, 60
Gilman, Charles Carroll	F. May 11, 1871	July 31, 1899	
Goad, Charles Edward	M. Sept. 7, 1881	June 10, 1910	
Golay, Philip	M. Sept. 5, 1877	Oct. 31, 1898	
Goodwin, Homer Stanley	M. July 20, 1870	Dec. 25, 1892	XIX, 163
Goodwin, John Marston	M. Sept. 4, 1872	Oct. 21, 1891	XVII, 267
Gorringe, Henry H	A. April 6, 1881	July 6, 1885	XVI, 215
Gorsuch, Robert Bennett	H. M. Jan. 9, 1905	June 2, 1906	
Gottlieb, Abraham	M. Sept. 4, 1872	Feb. 9, 1894	XX, 76
Gould, Edward Sherman	M. Nov. 4, 1885	Jan. 24, 1905	*LIV, 528*
Gowen, Charles Sewall	M. Mar. 7, 1888	Oct. 19, 1909	
Graff, Frederic	M. May 7, 1873	Mar. 30, 1890	XVII, 247
Graham, Joseph Marshall	M. April 4, 1900	Feb. 3, 1909	*LXIV, 583*
Grain, William	M. Sept. 15, 1869	Jan. 10, 1877	
Grant, William Harrison	M. July 2, 1873	Oct. 12, 1896	*XXXVI, 557*
Grassau, H	M. July 6, 1853	May 16, 1870	
Green, Rutger Bleecker	J. 1896 A. M. 1898 M. Sept. 6, 1904	Dec. 8, 1908	*LXIV, 585*
Greene, Benjamin Henry	M. May 1, 1878	Jan. 4, 1890	XVI, 187
Greene, Charles Ezra	M. Jan. 4, 1882	Oct. 17, 1903	
Greene, David Maxson	M. May 20, 1868	Nov. 9, 1905	*LVI, 466*
Greene, Edward Appleton	M. July 4, 1888	April 19, 1903	
Greene, George Sears	M. 1852 H. M. Oct. 26, 1888	Jan. 28, 1899	*XLIX, 335*
Greene, Joseph Norton	M. Oct. 5, 1887	July 26, 1904	*LV, 446*
Greenwood, William Henry	M. Mar. 3, 1880	Aug. 29, 1880	VII, 89
Gridley, Vernon Hill	J. Feb. 4, 1896	Sept. 17, 1896	*XXXVI, 595*
Griffen, John	M. April 15, 1868	Jan. 14, 1884	XII, 38
Griffin, Eugene	M. June 7, 1899	April 10, 1907	
Guild, Josephus Conn	M. June 1, 1898	Feb. 25, 1907	*LIX, 540*
Gurnee, Walter S	F. May 10, 1870	April 17, 1903	
Gzowski, *Sir* Casimir Stanislaus	M. Dec. 2, 1868	Aug. 24, 1898	*XLII, 567*
Haddock, Arba Read	A. May 4, 1881	Feb. 28, 1885	XIX, 67
Haines, Frank March	M. Mar. 1, 1905	June 1, 1905	
Hall, George Thomas	A. 1872 M. Sept. 2, 1874	June 2, 1881	VII, 97
Hamlin, Charles Edward	A. Jan. 2, 1894	Jan. 20, 1902	
Handy, Edward Adino	M. Jan. 2, 1889	Nov. 21, 1907	
Hannaford, Edmund Phillips	M. Sept. 18, 1872	Aug. 19, 1902	
Harbaugh, Springer	F. May 19, 1871	Dec. 8, 1887	XV, 46
Hardee, Thomas Sydenham	M. April 4, 1877	May 20, 1880	XII, 66
Harding, Henry	M. May 7, 1873	Oct. 23, 1910	
Harding, Horace	M. Nov. 2, 1892	July 29, 1899	*XLIII, 618*
Hardy, George Richardson	M. Nov. 7, 1888	April 2, 1903	
Harper, John Bradford	M. Oct. 4, 1905	Mar. 24, 1908	
Harris, Charles Marshall	A. Jan. 8, 1873	Oct. 28, 1909	
Harris, Henrique	M. Dec. 3, 1873	Oct. 10, 1882	*XXXVII, 562*
Harris, Robert Lewis	M. May 3, 1876	Sept. 29, 1896	
Harrison, Stephen A	F. Jan. 30, 1873	June 6, 1898	
Harrod, Thomas	J. Dec. 3, 1891	Dec. 31, 1896	
Hasbrouck, Charles Alfred	A. M. 1892 M. Dec. 5, 1894	Feb. 1, 1910	*LXX, 473*
Hasell, Bentley Douglas	M. July 3, 1878	May 29, 1900	

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† Date of death unknown.

Name	Date of Election	Date of Death	Memoirs*
Hasie, Montague Sylvester	M. Feb. 3, 1897	May 30, 1907	....
Haskell, Charles Frederic Beales	M. Oct. 7, 1891	May 20, 1895	XXI, 181
Haslett, Sullivan	M. June 4, 1879	Jan. 4, 1887	XIII, 127
Haswell, Charles Haynes	M. 1868 H. M. May 12, 1905	May 12, 1907	*LXI, 553*
Hatfield, Robert G	M. Dec. 4, 1867	Feb. 15, 1879	*XXXVI, 558*
Hausman, Frederick Appel	J. Feb. 3, 1903	Mar. 6, 1906	*LVII, 533*
Hawes, Louis Edwin	A. M. Sept. 2, 1896	Jan. 29, 1911	....
Hawkshaw, *Sir* John	H. M. Nov. 3, 1880	June 2, 1891	XVII, 250
Haycroft, James Isaac	A. M. Jan. 3, 1894	April 11, 1908	*LXII, 564*
Hayes, Richard Somers	M. Sept. 6, 1882	Mar. 2, 1905	*LV, 448*
Hayward, James A	M. Sept. 5, 1877	Aug. 13, 1880	VII, 88
Hegeman, Allen Bogardus	M. Feb. 1, 1888	Oct. 22, 1892	XIX, 171
Hemming, Dunkin Wirgman	A. M. 1892 M. May 31, 1904	Mar. 22, 1906	*LIX, 543*
Henry, Daniel Farrand	M. July 7, 1875	May 13, 1907	....
Hequembourg, Charles Ezra	M. June 5, 1901	Oct. 17, 1907	*LIX, 545*
Hermany, Charles	M. Jan. 6, 1869	Jan. 18, 1908	*LXV, 525*
Hildenbrand, Wilhelm	M. Feb. 5, 1902	Feb. 21, 1908	....
Hildreth, Russell Wadsworth	J. Jan. 4, 1888	Dec. 23, 1895	*XXXVI, 596*
Hilgard, Julius Erasmus	M. July 10, 1872	May 8, 1891	XVIII, 189
Hillman, Charles La Fletcher	M. July 5, 1876	June 14, 1902	*XLIX, 345*
Hilton, George Porter	M. May 1, 1889	Oct. 7, 1909	....
Hislop, John	M. May 1, 1895	Feb. 22, 1901	....
Hite-Smith, Van Dusen	A. M. April 3, 1901	Aug. 27, 1905	*LVI, 479*
Hjortsberg, Maximilian	M. July 10, 1872	May 16, 1880	VIII, 118
Hobby, Arthur Stanley	M. June 6, 1894	May 28, 1902	*XLIX, 347*
Hoe, Richard March	M. Oct. 1, 1873	June 8. 1886	XVI, 170
Holbrook, Henry Randolph	M. Jan. 2, 1890	Dec. 21, 1907	....
Holley, Alexander Lyman	M. Oct. 1, 1873	Jan. 29, 1882	XVI, 212
Horan, John Joseph	A. M. Oct. 7, 1908	Nov. 9, 1909	*LXVII, 634*
Houston, John	M. May 6, 1868	Aug. 30, 1896	*XXXIX, 694*
Howe, Horace Joseph	J. 1888 M. Mar. 2, 1898	Jan. 21, 1911	....
Howe, Milton Grosvenor	M. Oct. 16, 1872	June 19, 1902	*XLIX, 349*
Howell, Charles W	M. Mar. 3, 1875	April 5, 1882	VIII, 121
Howell, George Washington	M. May 2, 1888	Feb. 15, 1901	*XLIX, 351*
Howland, George, Jr	F. June 6, 1870	Feb. 18, 1892	XX, 154
Humphrey, Henry Cyprian	A. M. 1901 M. Oct. 3, 1905	Dec. 7, 1909	*LXVII, 630*
Humphrey, William Sheldon	A. M. Sept. 2, 1891	April 18, 1895	XXI, 98
Humphreys, Andrew Atkinson	H. M. May 7, 1873	Dec. 27, 1883	XVI, 218
Humphreys, Charles	M. Feb. 1, 1905	Nov. 18, 1906	*LVIII, 534*
Hunt, Alfred Ephraim	M. Sept. 1, 1886	April 26, 1899	*XLVI, 557*
Hunt, Randell	M. May 2, 1883	Jan. 24, 1898	*XLV, 629*
Huntington, Collis Potter	F. Mar. 10, 1877	Aug. 13, 1900	....
Hutton, Nathaniel Henry	M. June 3, 1896	May 8, 1907	*LX, 581*
Hutton, William Rich	M. Jan. 8, 1873	Dec. 11, 1901	....
Hyde, William Birelie	M. July 12, 1877	June 8, 1882	XVI, 172
Irwin, Roger Brooke	A. M. May 3, 1910	May 23, 1910	....
Ives, Edward Bernard	M. April 5, 1893	Dec. 30, 1903	....
Jackson, Jones Mumford	M. Sept. 1, 1886	Aug. 31, 1906	....
Jackson, William	M. Sept. 3, 1884	June 30, 1910	....
James, John Collinson	M. Mar. 1, 1876	Feb. 27, 1883	XVI, 164
Jennings, Henry Clay	M. April 6, 1887	Mar. 13, 1894	XX, 88
Jennings, William Tyndale	M. April 2, 1884	Oct. 24, 1906	....
Jervis, John Bloomfield	M. 1867 H. M. 1868 F. Mar. 19, 1880.	Jan. 12, 1885	XI, 109
Jewett, William Bradford	J. June 4, 1891	Nov. 7, 1894	XX, 202
Johnson, Archibald	M. April 6, 1898	Oct. 3, 1899	....
Johnson, Charles Roberts	M. June 3, 1885	Sept. 11, 1893	XX, 45
Johnson, John Butler	M. April 7, 1886	June 23, 1902	*LI, 454*
Johnson, Lorenzo Medici	J. 1875 M. April 7, 1880	Nov. 28, 1904	....
Johnson, Luther Elman	J. Sept. 6, 1904	Mar. 23, 1910	*LXX, 480*
Johnson, T. Marr	M. Feb. 26, 1872	July 31, 1874	I, 171
Johnson, Wallace Clyde	M. Oct. 5, 1892	Dec. 15, 1906	*LVIII, 538*
Johnston, Andrew Langstaff	M. June 4, 1890	May 15, 1901	....
Jones, Benjamin Franklin	F. June 13, 1870	May 19, 1903	....
Jones, Washington	M. Oct. 7, 1874	July 30, 1910	....
Jordan, Gabriel	M. Sept. 18, 1872	Nov. 10, 1884	XVI, 184
Joy, James Frederic	F. Nov. 6, 1872	Sept. 24, 1896	*XXXVII, 575*
Judah, Theodore Dehone	M. May 4, 1853	Nov. 2, 1863	*XXXVIII, 448*
Keefer, Samuel	M. Jan. 6, 1869	Jan. 9, 1890	XVI, 220
Kenyon, George Cecil	A. M. 1900 M. June 6, 1905	Oct. 30, 1906	....
Kernot, William Charles	M. Mar. 6, 1889	Mar. 14, 1909	*LXVI, 499*

DECEASED MEMBERS K-M

Name	Date of Election	Date of Death	Memoirs*
Killebrew, Samuel	M. Sept. 2, 1885	Jan. 9, 1899	*XLI, 639*
King, Charles Cyrus	M. Sept. 2, 1891	Jan. 13, 1911	....
Kingsley, William C	M. June 6, 1870	Feb. 21, 1885	*XXXVI, 612*
Kinney, Edward Cornelius	M. May 3, 1882	Jan. 16, 1910	....
Kirkwood, James Pugh	M. Nov. 5, 1852	April 22, 1877	IV, 60
Kloman, Andrew	F. Jan. 27, 1875	Dec. 19, 1880	VII, 122
Knight, William Baker	J. 1875 M. Jan. 7, 1880	Dec. 7, 1890	XVII, 277
Knowlton, Charles Andrews	M. Oct. 2, 1901	Mar. 2, 1903	*LV, 451*
Krupp, Alfred	F. June 14, 1870	July 14, 1887	*XXXVI, 609*
Lane, Moses	M. Dec. 4, 1867	Jan. 25, 1882	XIX, 58, 101
Lassig, Moritz	M. April 2, 1884	Jan. 7, 1902	*XLIX, 353*
Latcha, Jacob Albert	M. May 7, 1873	Nov. 30, 1904	*LIV, 531*
Latham, Norman Smith	J. July 3, 1889	Nov. 10, 1903	*LIV, 542*
Latimer, Charles	M. April 5, 1876	Mar. 25, 1888	XV, 137
Latrobe, Charles Hazlehurst	M. Nov. 16, 1870	Sept. 19, 1902	....
Laurie, James	M. Nov. 5, 1852	Mar. 16, 1875	*XXXVII, 553*
Lavelle, Louis Ralph	A. M. Feb. 1, 1905	Nov. 15, 1905	....
Law, Arthur Price	A. M. June 3, 1903	Nov. 19, 1906	*LVIII, 547*
Lawler, John	F. April 28, 1883	Feb. 23, 1891	....
Lawson, William Bateman	M. Feb. 1, 1893	Jan. 27, 1901	*XLVI, 560*
Lawton, Frederick Beecher	J. 1891 A. M. Nov. 4, 1896	Oct. 13, 1897	....
Lederle, George Anthony	J. 1883 M. Oct. 6, 1886	Mar. 27, 1905	....
Lee, George William	J. 1902 A. M. Jan. 2, 1907	Jan. 6, 1911	....
Leers, Frank Adolph	M. May 4, 1887	May 19, 1890	XX, 85
Lesage, Louis	M. Sept. 7, 1881	Jan. 9, 1889	XVI, 96
Leutzé Trevor McClurg	M. Feb. 3, 1897	Oct. 14, 1901	....
Leverich, Gabriel	M. July 6, 1870	Nov. 28, 1905	*LVI, 469*
Lewis, Isaiah William Penn	M. Jan. 5, 1853	Oct. 18, 1856	*XXXVIII, 453*
Lewis, James Frederick	A. Feb. 6, 1889	July 23, 1901	....
Libby, Edmund Dorman	M. May 6, 1885	April 24, 1903	....
Lincoln, William Shattuck	M. Dec. 5, 1883	May 16, 1902	*LI, 457*
Lindenberger, Cassius Howard	A. Feb. 2, 1892	Jan. 5, 1905	....
Lindenthal, Dominik	A. M. Mar. 4, 1896	June 7, 1900	*XLV, 637*
Linville, Jacob Hays	M. Mar. 3, 1875	Aug. 4, 1906	*LIX, 549*
Livingston, Julius I	A. July 3, 1889	Mar. 1, 1910	....
Locke, Augustus Woodbury	M. June 7, 1882	May 14, 1893	XIX, 172
Lockwood, John	A. April 5, 1882	Dec. 9, 1891	XVIII, 192
Long, Dennis	F. Mar. 28, 1872	Oct. 8, 1893	....
Long, Thomas John	J. 1875 M. Jan. 7, 1880	Nov. 20, 1905	....
Looker, Henry Brigham	A. M. May 3, 1893	Jan. 3, 1905	*LVIII, 548*
Lord, Harold	J. Sept. 3, 1907	†	....
Lotz, William Herman	M. Sept. 1, 1875	Jan. 31, 1894	XX, 74
Lovecraft, Frederick Aaron	F. Nov. 1, 1892	Oct. 26, 1893	....
Lovett, Thomas Davis	M. May 3, 1871	Dec. 5, 1897	*XL, 571*
Lowe, Gorham Parsons	M. April 21, 1869	Jan. 8, 1894	XX, 72
Lowthorp, Francis C	M. 1868 F. Mar. 17, 1870	June 1, 1890	XX, 196
Ludlow, William	M. July 5, 1882	Aug. 30, 1901	....
Lusk, James Loring	M. Mar. 4, 1891	Sept. 25, 1906	....
Lyon, William M	F. Mar. 23, 1870	July 3, 1889	XVI, 112
Lyte, Francis Asbury	A. M. Oct. 5, 1892	June 24, 1896	*XXXVIII, 461*
Macfarlane, Arthur Keddie	J. Oct. 5, 1909	Nov. 1, 1910	....
MacHarg, William Storrs	M. Dec. 2, 1903	May 6, 1910	....
Maclennan, John Donald	M. Oct. 4, 1899	Feb. 26, 1907	....
MacLeod, John	M. July 10, 1872	Jan. 21, 1900	....
MacNaughton, James	M. May 5, 1880	Dec. 29, 1905	*LVI, 471*
MacRitchie, Charles	A. 1872 M. April 5, 1876	Jan. 27, 1909	*LXIV, 587*
Macy, Arthur	J. 1877 M. Dec. 2, 1885	April 14, 1891	*XXXVII, 562*
McAlpine, Charles LeGrand	M. Dec. 4, 1867	Jan. 11, 1884	*XXXVII, 563*
McAlpine, William Jarvis	M. 1853 H. M. Oct. 26, 1888	Feb. 16, 1890	XVIII, 115
McBee, Vardry Echols, Jr.	A. M. Oct. 7, 1908	June 20, 1910	....
McCalla, Richard Calvin	J. 1890 A. M. 1891 M. Dec. 5, 1894	June 13, 1904	*LV, 453*
McCurdy, John Egbert	M. April 1, 1896	Dec. 15, 1908	....
McGee, Van Norman	A. M. June 6, 1900	Sept. 28, 1904	*LIV, 538*
McKay, John Edwards	M. July 5, 1893	May 13, 1910	....
McKean, Reginald	A. M. May 2, 1894	Oct. 15, 1901	*XLIX, 366*
McKeown, Thomas	M. Dec. 3, 1879	June 7, 1904	....
McLaughlin, John Joseph	M. Nov. 1, 1893	Jan. 19, 1911	....
McNair, Thomas Speer	M. July 2, 1873	July 25, 1901	....
McVean, John Jay	M. Sept. 3, 1884	Aug. 21, 1910	....
Mahan, Dennis Hart	H. M. Mar. 2, 1853	Sept. 16, 1871	XIX, 161
Malézieux, Emile	H. M. Nov. 3, 1880	May 20, 1885	*XXXVI, 524*
Mann, George Edward	M. Sept. 3, 1884	Oct. 2, 1897	....
Mansfield, Martin William	M. July 5, 1882	Sept. 25, 1908	*LXIII, 431*
Marden, Henry Herman, Jr.	M. May 1, 1901	†	....

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† Date of death unknown.

Name	Date of Election	Date of Death	Memoirs*
Marindin, Henry Louis	M. May 7, 1884	Mar. 25, 1904	....
Marr, George Anson	M. Oct. 3, 1883	Mar. 24, 1905	*LV, 454*
Marshall, Charles Alfred	M. Oct. 1, 1884	May 31, 1889	XVI, 99
Marsland, Edward	M. Feb. 6, 1878	June 25, 1898	....
Martin, Charles Cyril	M. July 10, 1872	July 11, 1903	....
Martin, Robert Kirkwood	M. June 1, 1892	Nov. 24, 1893	XX, 43
Mason, Eddy D	M. 1872 F. Dec. 28, 1872	Dec. 19, 1874	I, 329
Mayer, August	A. M. June 1, 1892	Mar. 25, 1909	....
Meier, William	A. M. June 1, 1909	Feb. 14, 1910	*LXVIII, 485*
Mendell, George Henry	M. Sept. 6, 1876	Oct. 19, 1902	*LI, 459*
Menocal, Aniceto Garcia	M. Feb. 3, 1875	July 20, 1908	....
Mercur, Frederick	M. July 20, 1870	Jan. 17, 1888	XVII, 157
Meriwether, Niles	M. Nov. 1, 1871	Dec. 28, 1900	*XLV, 632*
Merrill, William Emery	M. Oct. 6, 1872	Dec. 14, 1891	XVIII, 90
Merz, Frederick W	F. May 28, 1872	Dec. 8, 1883	*XXXVI, 615*
Metcalf, William	M. July 2, 1873	Dec. 5, 1909	....
Meyer, Thomas C	M. Dec. 7, 1852	Jan. 26, 1908	....
Michaelis, Otho Ernest	M. May 6, 1874	May 1, 1890	XVII, 132
Michie, William Roberts	J. 1893 A. M. Oct. 7, 1896	Feb. 2, 1899	*XLI, 647*
Miller, Alexander Macomb	M. June 6, 1888	Sept. 14, 1904	....
Miller, Samuel H	M. Sept. 6, 1882	Mar. 18, 1891	XVII, 208
Miller, Silvanus, Jr	M. Mar. 2, 1887	Dec. 17, 1897	*XXXIX, 696*
Mills, James Ellison	M. Feb. 3, 1886	July 25, 1901	....
Milne, Peter	A. Jan. 7, 1896	June 9, 1902	....
Minturn, Rowland Robinson	M. Nov. 2, 1887	April 7, 1898	....
Mitchell, Alexander	F. June 13, 1883	April 19, 1887	XIII, 98
Mitchell, Henry	M. Jan. 7, 1880	Dec. 1, 1902	....
Mitchell, Stephen Arnold	M. Oct. 2, 1907	May 21, 1908	*LXII, 552*
Moffet, James David	A. M. 1891 M. Feb. 7, 1894	Nov. 3, 1899	....
Monroe, John Albert	M. Sept. 4, 1869	June 11, 1891	XIX, 148
Montony, Liberty Gilbert	J. 1892 A. M. Feb. 5, 1896	Oct. 20, 1909	....
Morison, George Shattuck	M. Jan. 6, 1875	July 1, 1903	*LIV, 513*
Morison, William Smith	A. M. April 6, 1904	May 1, 1905	....
Morley, James Henry	M. Oct. 6, 1886	Sept. 8, 1889	XVI, 110
Morley, William Raymond	M. Sept. 6, 1882	Jan. 3, 1883	IX, 121
Morrell, William H	M. Nov. 5, 1852	†	....
Morris, Gouverneur	M. Oct. 3, 1888	Dec. 30, 1897	*XXXIX, 698*
Morris, Robert Campbell	M. Jan. 7, 1874	Nov. 8, 1892	XVIII, 220
Morris, William W	M. Jan. 5, 1853	†	....
Morse, Henry Grant	M. April 7, 1880	June 2, 1903	....
Morse, James Otis	M. Feb. 9, 1853	Mar. 8, 1883	XIX, 47
Morton, Charles	M. Oct. 2, 1895	Aug. 28, 1909	....
Morton, John Henry	M. June 3, 1891	Feb. 8, 1892	XVIII, 105
Moulton, Mace	M. June 4, 1884	April 27, 1909	....
Murakami, Kyoichi	M. Sept. 4, 1901	Aug. 18, 1906	....
Murdoch, Gilbert	M. Sept. 7, 1881	May 28, 1894	XX, 152
Myers, Edmund Trowbridge Dana	M. May 2, 1888	May 12, 1905	....
Myers, George Higgins	J. June 1, 1909	Oct. 10, 1910	....
Myers-Beswick, William Beswick	M. Jan. 3, 1894	Dec. 27, 1904	*LIV, 534*
Neilson, Robert	M. Feb. 17, 1869	Oct. 12, 1896	*XXXVII, 564*
Nelles, George Thomas	M. Oct. 3, 1888	Nov. 15, 1907	*LX, 586*
Newell, John	M. Jan. 29, 1868	Aug. 26, 1894	XX, 172
Newham, Charles Edward	M. Dec. 7, 1887	Feb. 1, 1898	....
Newton, Isaac	M. Mar. 3, 1880	Sept. 25, 1884	XI, 128
Newton, John	H. M. April 30, 1884	May 1, 1895	....
Nichols, Norman James	M. Dec. 5, 1888	April 8, 1896	*XXXVI, 559*
Nichols, Othniel Foster	M. June 7, 1876	Feb. 4, 1908	*LXI, 564*
Nicholson, George Benson	M. May 1, 1878	Dec. 2, 1906	*LIX, 556*
Nickerson, Louis H	M. Sept. 18, 1872	May 6, 1877	....
Norman, George H	M. 1869 F. Mar. 23, 1870	Feb. 4, 1900	....
Northrup, Herbert Franklin	M. Jan. 6, 1892	Jan. 21, 1908	*LX, 588*
Norton, Frederick Oakford	F. June 4, 1879	Sept. 27, 1892	XVIII, 219
Norton, John Talcott	M. Nov. 3, 1897	Aug. 5, 1905	....
Nourse, Edwin Green	M. Sept. 3, 1884	Dec. 8, 1897	*XXXIX, 699*
Noyes, Albert Franklin	M. Dec. 3, 1884	Oct. 12, 1896	*XXXVI, 560*
Oberndorf, Paul Ernest	J. Feb. 5, 1907	Oct. 13, 1907	*LX, 595*
Ogden, William B	F. Mar. 23, 1870	Aug. 3, 1877	IV, 67
Olney, Robert Blum	J. 1895 A. M. Sept. 5, 1900	Mar. 4, 1903	*L, 510*
O'Melveny, John Charles	M. May 4, 1898	Oct. 3, 1899	....
O'Sullivan, Thomas S	M. Jan. 5, 1853	Nov. 1, 1855	....
Paddock, Joseph Hill	M. Oct. 5, 1892	April 4, 1894	XX, 89
Paine, Charles	M. Dec. 4, 1867	July 4, 1906	*LX, 575*

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† Date of death unknown.

DECEASED MEMBERS P-R

Name	Date of Election	Date of Death	Memoirs*
Paine, William Henry	M. May 12, 1875	Dec. 31, 1890	XVII, 160
Palmer, Cornelius	M. Nov. 2, 1887	July 31, 1903	....
Parker, Charles Francis	J. Mar. 5, 1890	Oct. 10, 1898	....
Parker, William	M. Mar. 7, 1900	Sept. 30, 1909	....
Parkhurst, Henry Williams	M. Sept. 5, 1877	April 7, 1906	....
Patterson, John Austin	M. May 2, 1900	May 3, 1903	....
Pearson, William Anson, Jr.	M. Sept. 6, 1905	May 26, 1908	....
Pearsons, Galen W.	M. Jan. 6, 1875	Aug. 19, 1907	....
Pennypacker, Levis Passmore	A. M. April 1, 1891	Jan. 30, 1901	*XLVI, 570*
Perrine, Frederic Auten Combs	M. May 3, 1905	Oct. 20, 1908	....
Petry, Alfred	M. Oct. 6, 1886	May 14, 1901	....
Philbrick, Edward Southwick	M. May 6, 1874	Feb. 13, 1889	*XXXVIII, 454*
Phillips, William	F. Mar. 23, 1870	April 14, 1874	I, 169
Phinney, Henry Ward Beecher	M. Jan. 7, 1885	Nov. 22, 1888	*XXXVI, 563*
Pierce, William Thomas	M. May 6, 1896	Feb. 26, 1906	*LVII, 525*
Pike, William Abbot	M. Dec. 3, 1890	Oct. 13, 1895	XXI, 212
Platt, Joseph Curtis	M. July 2, 1895	July 7, 1898	....
Plympton, George Washington	M. Jan. 29, 1868	Sept. 11, 1907	....
Poe, Orlando M.	M. Jan 8, 1873	Oct. 2, 1895	....
Poinier, P. Porter	J. Mar. 3, 1875	June 11, 1876	IV, 74
Pope, Macy Stanton	A. M. May 2, 1900	Dec. 10, 1904	*LIV, 540*
Pope, Willard Smith	M. Aug. 7, 1872	Oct. 10, 1895	*XXXVI, 565*
Porter, Albert Howell	J. 1888 A. M. July 1, 1891	Aug. 9, 1899	....
Post, Andrew Jackson	M. Nov. 1, 1871	Mar. 12, 1896	....
Post, James Clarence	M. Feb. 6, 1878	Jan. 6, 1896	*XXXVI, 569*
Post, Simeon S.	M. Nov. 5, 1852	June 29, 1872	XIX, 49
Potts, Joseph Dilwyn	M. Aug. 5, 1868	Dec. 3, 1893	XX, 49
Potts, Richard	M. June 1, 1870	July 11, 1891	XVII, 242
Powell, Charles Francis	M. Oct. 3, 1888	July 30, 1907	*LXI, 567*
Poynor, David Ashley	M. June 1, 1892	May 29, 1906	....
Pratt, Thomas Willis	M. 1853 F. Nov. 4, 1870	July 17, 1875	I, 332
Pratt, William Arthur	M. Dec. 4, 1895	Sept. 19, 1904	....
Prendergast, Francis Ensor	M. Mar. 7, 1888	Dec. 7, 1897	*XXXIX, 701*
Prevost, Sutherland Mallet	M. Jan. 6, 1875	Sept. 30, 1905	....
Price, Philip M.	M. May 2, 1888	Oct. 4, 1894	XX, 200
Prince, Edward	J. 1878 M. Nov. 1, 1882	Dec. 12, 1908	....
Probasco, Samuel R.	M. Nov. 18, 1868	Jan. 19, 1910	....
Prosser, Thomas	M. Dec. 4, 1867	Sept. 15, 1870	*XXXVI, 564*
Prosser, Thomas	F. June 1, 1870	Jan. 6, 1896	....
Putnam, Joseph W.	A. Mar. 3, 1880	Mar. 24, 1893	XX, 87
Quinette de Rochemont, *Baron* Emile Theodore	M. Jan. 3, 1894	Dec. 8, 1908	....
Quinlan, George Austin	M. Oct. 4, 1893	Aug. 29, 1901	....
Rafter, George W.	M. April 2, 1884	Dec. 29, 1907	*LXII, 554*
Randolph, James Lingan	M. Mar. 1, 1882	Sept. 17, 1888	XVIII, 217
Raymond, Thomas Laidlaw	M. Oct. 6, 1897	Nov. 15, 1901	*XLIX, 354*
Reece, Benjamin	M. Mar. 2, 1881	Dec. 17, 1901	....
Reed, Edward M.	M. July 10, 1872	Feb. 13, 1892	XVIII, 94
Reed, Henry Wadsworth	M. Jan. 6, 1886	Oct. 26, 1900	....
Reed, Samuel Benedict	M. Oct. 20, 1869	Dec. 25, 1891	XVIII, 183
Reed, William Ward	F. Dec. 20, 1872	Jan. 10, 1904	*LII, 558*
Rees, William Marshall	M. Oct. 4, 1905	Dec. 4, 1905	*LVI, 473*
Reeves, Samuel J.	M. April 5, 1868	Dec. 15, 1878	V, 93
Reinholdt, Kenneth Oake Plummer	J. 1894 A. M. Oct. 7, 1896	Feb. 6, 1902	*XLIX, 368*
Reiseger, Marc John	M. Dec. 7, 1898	May 26, 1900	*XLV, 634*
Reno, James Hart	M. Nov. 5, 1879	Aug. 5, 1881	*XXXVII, 566*
Rhodes, Benjamin	M. April 5, 1882	Aug. 12, 1894	XX, 163
Rhys-Roberts, Edmund Alyth	A. M. Nov. 3, 1897	Oct. 5, 1909	....
Rice, Edward Curtis	M. April 7, 1875	April 21, 1898	*XXXIX, 703*
Rice, Lewis Frederick	M. Jan. 2, 1889	April 13, 1909	....
Rich, Watson Wellman	M. Sept. 5, 1883	Jan. 12, 1903	*L, 501*
Richards, Joseph Ruggles	A. Feb. 4, 1880	Sept. 28, 1900	*XLV, 640*
Richardson, B. Frank	M. July 1, 1885	April 18, 1904	....
Richardson, Clinton Leroy	J. 1902 A. M. Oct. 2, 1907	July 7, 1910	....
Richardson, Henry Brown	M. May 7, 1879	Aug. 21, 1909	*LXVI, 501*
Riffle, Albert Stanley	M. May 7, 1890	Oct. 28, 1909	*LXVI, 504*
Rinecker, Francis	M. Aug. 7, 1872	April 10, 1899	*XLII, 569*
Rives, Alfred L.	M. Sept. 4, 1872	Feb. 27, 1903	....
Roberts, Evelyn Pierrepont	M. May 7, 1884	Dec. 30, 1910	....
Roberts, William	A. June 4, 1884	Dec. 28, 1907	*LX, 593*
Roberts, William Milnor	M. Sept. 21, 1870	July 14, 1881	*XXXVI, 531*
Robinson, George Henry	M. Mar. 7, 1888	July 4, 1906	....
Robinson, Moncure	H. M. July 6, 1853	Nov. 10, 1891	XVIII, 84
Robinson, Stillman Williams	M. Jan. 2, 1884	Oct. 31, 1910	....

Name		Date of Election	Date of Death	Memoirs*
Roebling, John Augustus	M.	Dec. 2, 1868	July 22, 1869	....
Rogers, Albert Brainerd	M.	June 6, 1883	May 4, 1889	XVI, 98
Rogers, Fairman	M.	May 7, 1873	Aug. 22, 1900	....
Rogers, John Benjamin	M.	Aug. 4, 1873	April 1, 1874	I, 168
Rogers, Merritt Harrison	M.	Jan. 2, 1890	May 3, 1907	*LIX, 562*
Rohnert, Benno	J.	April 3, 1889	Sept. 1, 1906	*LVIII, 557*
Rosecrans, William Starke	M.	July 5, 1882	Mar. 11, 1898	....
Rosenzweig, Alfred	J.	1882 M. Jan. 4, 1893	Jan. 13, 1904	....
Rosewater, Andrew	M.	Oct. 3, 1883	April 17, 1909	....
Rothwell, Richard Pennefather	M.	Jan. 29, 1868	April 17, 1901	....
Rowe, Robert Delos	M.	Jan. 2, 1890	Mar. 14, 1899	*XLII, 571*
Rowe, Samuel McMath	M.	Sept. 2, 1885	May 22, 1910	....
Rowland, Thomas Fitch	M.	1867 H. M. Dec. 20, 1899	Dec. 13, 1907	*LXII, 547*
Rudolff, Henry Frederick	M.	Jan. 6, 1886	June 1, 1895	*XXXVI, 570*
Rumsey, Bronson C	F.	May 12, 1870	†	....
Rusling, George McCracken	M.	Nov. 1, 1882	Feb. 26, 1901	....
Russell, Nathaniel Edwards	M.	Oct. 3, 1888	Jan. 14, 1902	*XLIX, 355*
St. John, Isaac Munroe	M.	July 14, 1871	April 7, 1880	*XXXVI, 571*
Sample, John Henderson	M.	Oct. 6, 1886	Mar. 4, 1910	*LXX, 474*
Sanderson, James Gardner	M.	July 6, 1881	Nov. 15, 1909	....
Schaub, Julius William	J.	1884 M. Oct. 6, 1886	Mar. 30, 1909	....
Schermerhorn, Louis Younglove	M.	May 5, 1897	April 3, 1908	....
Scherzer, Albert John	M.	Jan. 6, 1886	†	....
Scherzer, William	M.	Sept. 5, 1888	July 20, 1893	XX, 58
Schofield, Mark William	M.	May 1, 1907	Nov. 27, 1908	*LXIII, 432*
Schott, Charles Ridgely	M.	April 1, 1874	July 9, 1878	IV, 128
Schuyler, Howard	M.	June 7, 1882	Dec. 3, 1883	*XXXVI, 572*
Schwitzer, John Edward	M.	July 10, 1907	Jan. 23, 1911	....
Scott, William Lawrence	F.	July 7, 1870	Sept. 19, 1891	XVII, 285
Scott, William Ulysses	A. M.	Feb. 3, 1897	Sept. 26, 1898	*XLII, 572*
Scowden, Theodore Ransom	M.	May 7, 1873	Dec. 31, 1881	....
Seaton, William, Jr	A. M.	June 4, 1902	Jan. 18, 1908	....
Seaver, John Wright	M.	Nov. 6, 1901	Jan. 14, 1911	....
Seely, Thomas Jennings	M.	Feb. 1, 1882	Oct. 2, 1883	*XXXVI, 574*
Seitzinger, William White	J.	Oct. 2, 1889	Sept. 21, 1900	....
Sellers, Coleman	M.	May 3, 1876	Dec. 28, 1907	....
Seymour, Horatio	A.	1873 M. April 7, 1880	Feb. 21, 1907	*LXVI, 507*
Seymour, Mark Tucker	F.	July 21, 1870	May 30, 1885	*XXXVII, 578*
Shaler, Ira Alexander	J.	1888 M. June 5, 1895	June 29, 1902	*XLIX, 357*
Shanks, Thomas Pearman	M.	May 2, 1888	Jan. 7, 1904	....
Shanley, James Roosevelt	A.	Mar. 6, 1907	Aug. 25, 1910	....
Sheldon, Simeon	M.	Feb. 5, 1873	Mar. 4, 1883	....
Shinbur, Elver La Zelle	A. M.	Oct. 3, 1906	Nov. 7, 1906	*LVII, 531*
Shinn, William Powell	M.	Sept. 15, 1869	May 5, 1892	XVIII, 123
Shirreffs, Reuben	M.	June 4, 1890	Aug. 31, 1904	....
Shreve, Samuel Henry	M.	May 19, 1869	Nov. 27, 1884	*XXXVI, 576*
Sicard, Mirtiliano	M.	Jan. 4, 1882	Mar. 17, 1896	*XL, 577*
Sickels, Frederick Ellsworth	M.	Jan. 7, 1891	Mar. 9, 1895	*XXXVI, 577*
Sickels, Theophilus E	M.	Feb. 21, 1872	Feb. 4, 1885	XI, 130
Sidell, William H	M.	Dec. 1, 1852	July 1, 1873	I, 41
Sites, Wilmon W. C	M.	Nov. 6, 1878	Oct. 1, 1885	*XXXVI, 582*
Slataper, Felician	M.	Sept. 15, 1869	Sept. 11, 1906	*LVIII, 540*
Sleeper, George Edward	M.	Feb. 3, 1904	Oct. 25, 1908	....
Sloan, Robert Imlay	M.	Oct. 1, 1884	May 3, 1901	*XLVI, 562*
Smedley, Samuel Lightfoot	M.	Sept. 2, 1874	July 21, 1894	XXI, 88
Smith, Albert Mather	M.	May 5, 1886	Feb. 27, 1910	*LXX, 476*
Smith, Benjamin Burgh	M.	Nov. 7, 1888	Feb. 8, 1904	*LII, 550*
Smith Charles Augustus	M.	April 7, 1880	Feb. 2, 1884	XI,122
Smith, Charles C	M.	July 10, 1872	April 17, 1889	XV, 142
Smith, Charles Shaler	M.	Mar. 5, 1873	Dec. 19, 1886	XIII, 105
Smith, Charles Vandervoort	M.	July 5, 1876	June 30, 1884	XI, 126
Smith, David Lowber	M.	May 4, 1887	Oct. 10, 1893	XX, 57
Smith, Frederick Henry	M.	Feb. 21, 1872	Dec. 24, 1898	*XLI, 643*
Smith, Hamilton	M.	Feb. 5, 1879	July 4, 1900	*XLVI, 564*
Smith, Isaac Williams	M.	Oct. 1, 1873	Jan. 1, 1897	*XXXVIII, 456*
Smith, Lucius A	M.	May 7, 1873	Jan. 5, 1894	XX, 48
Snyder, Francis Edward	M.	Sept. 6, 1905	Dec. 23, 1905	....
Soper, Ralph Carroll	A. M.	Aug. 31, 1909	June 16, 1910	....
Sosa, Pedro José	M.	Dec. 3, 1884	July 4, 1898	....
Spalding, Ira	M.	Aug. 2, 1870	Oct. 2, 1875	I, 338
Spencer, Samuel	M.	Sept. 2, 1885	Nov. 29, 1906	....
Spielmann, Arthur	A.	1873 M. Sept. 5, 1877	Nov. 29, 1883	X, 115
Spier, Charles Louis	A.	May 3, 1905	May 7, 1906	....
Spörck, Karl	M.	Mar. 2, 1898	June 23, 1899	....
Sproul, Archibald Alexander	M.	May 1, 1907	April 26, 1910	....

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† Date of death unknown.

DECEASED MEMBERS S-W

Name	Date of Election	Date of Death	Memoirs*
Stahlberg, Albert Jacob	J. Mar. 4, 1874	Aug. 19, 1887	*XXXVI, 597*
Stanwood, James Hugh	A. M. Oct. 3, 1894	May 24, 1896	*XXXVI, 590*
Starling, William	M. Sept. 7, 1887	Dec. 11, 1900	*XLVI, 566*
Starr, William Wright	M. May 1, 1907	†	....
Steele, Henry Maynadier	A. M. 1893 M. Dec. 6, 1899	July 5, 1909	*LXVII, 631*
Stewart, David A	F. Nov. 7, 1872	Dec. 14, 1888	XIX, 160
Stewart, Herbert	A. Feb. 6, 1894	Mar. 4, 1899	....
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Thomson, George Huntington	M. Feb. 2, 1887	Feb. 7, 1910	....
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† Date of death unknown.
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Winans, L. L.	Jun.	172
Winchester, P. H.	Assoc. M.	149
Winchester, T. H.	Jun.	172
Windsor, P. B.	M.	99
Winfree, P. B.	Assoc. M.	149
Wing, C. B.	M.	99
Wing, F. K.	Assoc. M.	149
Wingfield, N.	M.	99

		Page
Winn, W. S.	Assoc. M.	149
Winslow, A. E.	Assoc. M.	149
Winslow, B. E.	M.	99
Winslow, C. P.	Assoc. M.	149
Winsor, F. E.	M.	99
Winsor, H. D.	Jun.	172
Winterhalter, L. P.	Assoc. M.	150
Wintermute, F. C.	Jun.	172
Wise, C. R.	M.	99
Wise, J. H.	Assoc. M.	150
Wise, R. S.	Jun.	172
Wisner, G. M.	M.	99
Witham, M. E.	Assoc. M.	150
Witherell, F. W.	Assoc. M.	150
Witmer, F. P.	M.	99
Witmer, J. F.	M.	99
Witt, C. C.	M.	99
Wittstein, H. L.	Jun.	172
Woermann, F. C.	M.	99
Woermann, J. W.	M.	99
Wolcott, C. S.	Assoc. M.	150
Wolf, J. H. G.	M.	99
Wolfe, C. J.	M.	99
Wolfe, F. C.	M.	99
Wölfel, P. L.	M.	99
Wolff, H. H.	Assoc. M.	150
Wolff, L. P.	M.	99
Wolkowyski, A. I.	Jun.	172
Wolstenholme, A.	M.	99
Wolverton, I. M.	M.	99
Wonson, S. L.	Assoc. M.	150
Wood, A. B.	M.	99
Wood, C. W.	M.	99
Wood, D. H.	M.	99
Wood, E. N.	M.	99
Wood, F. J.	M.	99
Wood, G.	Assoc. M.	150
Wood, G. R.	Assoc. M.	150
Wood, H. B.	M.	99
Wood, H. S.	M.	99
Wood, I. S.	M.	99
Wood, J.	M.	99
Wood, R. W.	Assoc. M.	150
Wood, W. B.	Assoc. M.	150
Wood, W. P.	M.	99
Woodard, S. H.	M.	99
Woodard, W.	Assoc. M.	150
Woodbury, C. J. H.	M.	99
Woodbury, J. McG.	Assoc.	155
Woodcock, H. W.	Assoc. M.	150
Woodle, A. S., Jr.	Assoc. M.	150
Woodman, A. W.	M.	99
Woodruff, C. W.	Jun.	172
Woodruff, E. L.	M.	99
Woods, A. A.	Assoc. M.	150
Woods, H. D.	M.	99
Woods, R. P.	M.	99
Woodward, E. C.	Assoc. M.	150
Woodworth, R. B.	M.	100
Wooldridge, C. L.	M.	100
Woolley, A. F.	M.	100
Wooten, W. P.	M.	100
Worcester, J. R.	M.	100

		Page
Work, J. Y.	Assoc. M.	150
Worley, J. S.	Assoc. M.	150
Wortendyke, N. D.	Assoc. M.	150
Wortham, J. R.	Assoc. M.	150
Worthington, C.	M.	100
Wrenn, J. F.	Assoc.	155
Wrentmore, C. G.	M.	100
Wright, A. E.	Jun.	172
Wright, A. W.	M.	100
Wright, C. H.	M.	100
Wright, E. T.	M.	100
Wright, J.	M.	100
Wright, John B.	M.	100
Wright, Joseph B.	M.	100
Wright, P. O., Jr.	M.	100
Wright, R. B.	Jun.	172
Wright, T. J., Jr.	Jun.	172
Wright, T. T.	Jun.	172
Wright, W. B.	M.	100
Wrigley, H. B.	Assoc. M.	150
Wrotnowski, A. F.	M.	100
Wyckoff, C. R., Jr.	Jun.	172
Wygant, R. C.	Jun.	172
Wyman, A. M.	Assoc. M.	150
Yamaguchi, J.	M.	100
Yappen, A.	Assoc. M.	150
Yarnell, D. L.	Jun.	172
Yates, B. C.	Assoc. M.	150
Yates, E. A.	Assoc. M.	150
Yates, J. J.	Assoc. M.	150
Yates, P. K.	M.	100
Yates, W. H.	Assoc. M.	150
Yeatman, C. P.	M.	100
Yeatman, M. E.	M.	100
Yeatman, P.	M.	100
Yen, T. C.	Assoc. M.	150
Yeo, W. A.	Jun.	172
Yeo, W. H. W.	Assoc. M.	150
Yereance, W. B.	M.	100
Yonge, S. H.	M.	100
York, H. W.	M.	100
Young, C. G.	Assoc.	155
Young, C. N.	Assoc. M.	150
Young, H. A.	Assoc. M.	150
Young, L. M.	Assoc. M.	150
Young, R. C.	M.	100
Young, S. McC.	M.	100
Yuille, N. A.	M.	100
Zabriskie, A. J.	Jun.	172
Zabriskie, A. M.	Assoc. M.	150
Zachry, J. L.	Assoc. M.	150
Zarbell, E.	M.	100
Zesiger, A. W.	M.	100
Ziesing, A.	M.	100
Ziffer, E. A.	M.	100
Zimmermann, W. G.	Assoc. M.	150
Zinn, A. S.	M.	100
Zinn, G. A.	M.	100
Zollinger, L. R.	M.	100
Zook, M. A.	M.	100
Zorn, G. W.	Assoc. M.	150

Total Membership, 5 858.

4339 0042

HOUSE OF THE SOCIETY,

220 West 57th Street.

Cable Address:
"Ceas, New York."

Telephone:
5913 Columbus.

CALENDAR.

1911-12.

DATES OF MEETINGS IN BOLD-FACED TYPE.

FEBRUARY, 1911

S	M	T	W	T	F	S
..	..	..	**1**	2	3	4
5	6	7	8	9	10	11
12	13	14	**15**	16	17	18
19	20	21	22	23	24	25
26	27	28	..	..	..	..
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MARCH

S	M	T	W	T	F	S
..	..	..	**1**	2	3	4
5	6	7	8	9	10	11
12	13	14	**15**	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	..
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APRIL

S	M	T	W	T	F	S
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9	10	11	12	13	14	15
16	17	18	**19**	20	21	22
23	24	25	26	27	28	29
30	..	..	..	..	..	..

MAY

S	M	T	W	T	F	S
..	1	2	**3**	4	5	6
7	8	9	10	11	12	13
14	15	16	**17**	18	19	20
21	22	23	24	25	26	27
28	29	30	31	..	..	..
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JUNE

S	M	T	W	T	F	S
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4	5	6	**7**	8	9	10
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25	26	27	28	29	30	..
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JULY

S	M	T	W	T	F	S
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16	17	18	19	20	21	22
23	24	25	26	27	28	29
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AUGUST

S	M	T	W	T	F	S
..	..	1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31	..	..
..	..	..	..	..	..	..

SEPTEMBER

S	M	T	W	T	F	S
..	..	..	..	..	1	2
3	4	5	**6**	7	8	9
10	11	12	13	14	15	16
17	18	19	**20**	21	22	23
24	25	26	27	28	29	30
..	..	..	..	..	..	..

OCTOBER

S	M	T	W	T	F	S
1	2	3	**4**	5	6	7
8	9	10	11	12	13	14
15	16	17	**18**	19	20	21
22	23	24	25	26	27	28
29	30	31	..	..	..	..
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NOVEMBER

S	M	T	W	T	F	S
..	..	..	**1**	2	3	4
5	6	7	8	9	10	11
12	13	14	**15**	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	..	..
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DECEMBER

S	M	T	W	T	F	S
..	..	..	..	..	1	2
3	4	5	**6**	7	8	9
10	11	12	13	14	15	16
17	18	19	**20**	21	22	23
24	25	26	27	28	29	30
31	..	..	..	..	..	..

JANUARY, 1912

S	M	T	W	T	F	S
..	1	2	**3**	4	5	6
7	8	9	10	11	12	13
14	15	16	**17**	18	19	20
21	22	23	24	25	26	27
28	29	30	31	..	..	..
..	..	..	..	..	..	..

NOTE.—Regular meetings are called to order at 8.30 P. M.

The House of the Society is open from 9 A. M. to 10 P. M. every day, except Sundays, Fourth of July, Thanksgiving Day and Christmas Day.

At the time of going to press the date of the Annual Convention had not been fixed.

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